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Preliminary Estimation of Isotopic Inventories of 2000 MWt ABR (Revision 1)

Nuclear Engineering Division

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Preliminary Estimation of Isotopic Inventories of 2000 MWt ABR (Revision 1)

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Abstract

The isotopic inventories of a 2000 MWt Advanced Burner Reactor (ABR) core have been estimated to support the ABR accident analysis to be reported in the Appendix D of the Programmatic Environmental Impact Statement (PEIS). Based on the Super-PRISM design, a preliminary core design of 2000 MWt ABR was developed to achieve a one-year cycle length with 3-batch fuel management scheme. For a bounding estimation of transuranics (TRU) inventory, a low TRU conversion ratio (~0.3) was targeted to increase the TRU enrichment. By changing the fuel compositions, isotopic inventories of mass and radioactivity were evaluated for four different core configurations: recycled metal fuel core, recycled oxide fuel core, startup metal fuel core, and startup oxide fuel core. For recycled cores, the TRU recovered from ABR spent fuel was used as the primary TRU feed, and the TRU recovered from 10-year cooled light water reactor spent fuel was used as the makeup TRU feed. For startup cores, weapons-grade plutonium was used as TRU feed without recycling ABR spent fuel. It was also assumed that a whole batch of discharged fuel assemblies is stored in the in-vessel storage for an entire irradiation cycle.

For both metal and oxide fuel cores, the estimated TRU mass at beginning of equilibrium cycle (BOEC), including spent fuel TRU stored in the in-vessel storage, was about 8.5 – 8.7 MT for the recycled cores and 5.2 MT for the startup cores. Since a similar power was generated, the fission product mass are comparable for all four cores: 1.4 MT at BOEC and about 2.0 MT at end of equilibrium cycle (EOEC). Total radioactivity at BOEC is about 8.2×10^{8} curies in recycled cores and about 6.9×10^{8} curies in startup cores, and increases to about 1.1×10^{10} curies at EOEC for all four cases. Fission products are the dominant contributor (more than 80%) to the total radioactivity at EOEC for all four cases, but the fission product radioactivity decreases by 79% after one-year cooling. The heavy metal radioactivity in recycled cores is higher than that of the startup core because of the higher TRU inventory at BOEC. The leading contributors at EOEC are U-239, Np-239, Am-242 and Pu-243 at EOEC, but these short-lived nuclides decay out quickly during the refueling time. As a result, the leading contributors at BOEC are Pu-241, Cm-242, Cm-244, and Pu-238.

1. Introduction

The isotopic inventories of a 2000 MWt Advanced Burner Reactor (ABR) core have been estimated to support the ABR accident analysis to be reported in the Appendix D of the Programmatic Environmental Impact Statement (PEIS) of Global Nuclear Energy Partnership (GNEP). Based on the Super-PRISM design [1,2], a preliminary core design of 2000 MWt ABR was developed to achieve a one-year cycle length with 3-batch fuel management scheme. By changing the fuel compositions, the isotopic inventories of mass and radioactivity were evaluated for four different core configurations: recycled metal fuel core, recycled oxide fuel core, startup metal fuel core, and startup oxide fuel core.

For a bounding estimation of transuranics (TRU) inventories, a low TRU conversion ratio was targeted to increase the TRU enrichment. Core size and fuel volume fraction were selected in such a way that the TRU conversion ratio of recycled equilibrium core is ~0.3 and a one-year cycle length is achieved with 3-batch fuel management scheme. Assembly design parameters were determined to yield the selected fuel volume fraction while satisfying the linear power limit with a sufficient margin. However, no attempt was made to optimize the core design since the main purpose of the work was to estimate the isotopic inventories. This preliminary core design was used for all four cases; only the fuel smeared density was varied between metal and oxide fuel assembly designs. For all four cases, the TRU enrichment was determined to meet the target cycle length of one-year, allowing the TRU conversion ratio to vary. For recycled cores, the TRU recovered from ABR spent fuel was used as the primary TRU feed, and the TRU recovered from 10-year cooled light water reactor spent fuel (LWR-SF) with 33 GWD/MT burnup was used as the makeup TRU feed. For startup cores, weapons-grade plutonium (WG-Pu) driver fuels were assumed without recycling ABR spent fuel, and twelve test fuel assemblies made of LWR-SF TRU were introduced.

Detailed isotopic inventories were estimated by REBUS-3/ORIGEN-2 coupled calculations. From REBUS-3 equilibrium cycle calculations, effective one-group cross sections of actinide isotopes and fresh fuel isotopic vectors of heavy metal nuclides were derived for different core regions. Using the data and the FFTF one-group cross sections for other isotopes, detailed isotopic depletion calculations were performed with the ORIGEN-2 code.

In Section 2, the computational methods and models used in ABR core designs are briefly described. The design and core performance parameters of the preliminary 2000 MWt ABR design are discussed in Section 3. The isotopic inventories of mass and radioactivity are presented in Section 4. The conclusions are given in Section 5.

2. Computational Methods and Models

The ANL suite of fast reactor analysis codes was used to evaluate core performance parameters and core inventories. Fuel cycle analyses were performed with the DIF3D/REBUS-3 code system [3,4]. The region-dependent 21-group cross section set previously generated for the metal and oxide fuel cores was used. This cross section set was generated based on the ENDF/B-V.2 file using the ETOE-2/MC^2-2/SDX code system [5-7]. Using 3-dimensional hexagonal-z geometry models, equilibrium cycle analyses were performed with scattered loading. Material thermal expansion at operating condition was modeled by adjusting the hexagonal pitch, axial meshes, and the fuel and structure volume fractions appropriately. For the metal fueled core, irradiation swelling of fuel was considered, and the bond sodium was displaced into the lower part of fission gas plenum. Block nuclide depletion was performed by dividing each fuel assembly into five axial depletion zones. For flux calculations, the hexagonal-z nodal diffusion theory option of DIF3D [8] was employed. The required TRU enrichment (i.e., TRU fraction in heavy metal) was determined from the equilibrium cycle analysis such that the multiplication factor at EOEC is 1.0. Enrichment zoning strategy was employed to flatten the power distribution, but no attempt was made to optimize the reactivity swing and discharge burnup.

Linear power limits were estimated by simple thermal-hydraulic calculations based on a single channel model. The coolant inlet and bulk outlet temperatures were assumed 355 °C and 510 °C, respectively. The average flow rate was determined such that the coolant temperature rise across the core is 155 °C. A chopped cosine shape was assumed for the axial power distribution. Hot channel factors of 2.67, 1.10, 1.48 and 1.24 were used for the film, cladding, gap and coolant regions, respectively. For metal alloy fuel, the fresh fuel thermal conductivity was determined as a function of U, TRU, and Zr weight fractions using the correlation for U-Pu-Zr fuel [9], and a porosity correction factor of 0.5 was applied to take into account the irradiation effects. The fuel solidus temperature was also estimated as a function of constituent mole fractions using the correlation for U-Pu-Zr fuel [10]. The fuel cladding eutectic temperature was conservatively assumed to be 650 °C. For mixed oxide fuel, the thermal conductivity and melting temperature correlations of Reference 11 were used, and the porosity correction factor of 0.75 was applied for thermal conductivity. The linear power limit was determined such that the peak fuel centerline temperature is lower than the fuel solidus temperature. For metal fuel, linear power was additionally limited such that the peak cladding inner-wall temperature is lower than the fuel cladding eutectic temperature.

Detailed isotopic mass and radioactivity of irradiated fuels were calculated using the ORIGEN-2 [12] code. In the ORIGEN-2 calculations, the initial heavy metal inventories at the beginning of equilibrium cycle (BOEC) were obtained from the REBUS-3 calculations. Since the heavy metal cross sections provided in ORIGEN-2 package are not appropriate to deplete these particular ABR fuels, the one-group cross sections determined from REBUS-3 equilibrium cycle calculations were used for actinide isotopes. However, the FFTF one-group cross section library of the ORIGEN-2 code package was used for other isotopes. By comparing the heavy

metal masses at discharge burnup between the results of ORIGEN-2 and REBUS-3 calculations, it was confirmed that the use of the actinide cross sections derived from REBUS-3 calculations yielded consistent depletion results.

3. Preliminary Design of 2000 MWt ABR

3.1. Core Configuration

Based on the 1000 MWt Super-PRISM design [2], a preliminary core design of 2000 MWt ABR core was developed for ternary metal alloy (U-TRU-Zr) and mixed oxide (UO_2-$TRUO_2$) fuels. Core size and fuel volume fraction were selected such that the TRU conversion ratio of a recycled equilibrium core with ternary metal fuel is ~0.3 and a one-year cycle length with 90% capacity factor is achieved for a 3-batch fuel management scheme. Assembly design parameters were determined to yield the selected fuel volume fraction while satisfying the linear power limit with a significant margin. However, no attempt was made to optimize the core design since the main purpose of the work was to estimate the core inventory.

This preliminary core design was used for both metal and oxide fuel cores, allowing the TRU conversion ratio to vary; only different fuel smeared densities were used as described in Section 3.2. The TRU recovered from ABR spent fuel was used as the primary TRU feed, and the TRU recovered from 10-year cooled LWR spent fuel with 33 GWD/MT burnup was used as the makeup TRU feed. For the reprocessing of ABR spent fuel, one-year cooling time and half-year reprocessing time were assumed. For the U-TRU-Zr ternary metal fuel, 20% Zr mass fraction was used to compensate the decreasing melting temperature of metal alloy fuel with increasing TRU fraction.

Figure 3.1 shows the planar core layout. The core is composed of 331 fuel assemblies, which are divided into three enrichment zones (inner, middle and outer cores) to flatten the power distribution. The active core is ~1 m high and the fission gas plenum is ~1.9 m high. The equivalent active core diameter is 3.36 m and the inner diameter of core barrel is 4.53 m. The core is surrounded successively by 162 radial reflectors and 90 shield assemblies. Two independent safety-grade reactivity control systems were used: primary and secondary control rod systems. The number of control assemblies was estimated to attain a sufficient shutdown margin with a maximum single rod worth less than 1$. However, further studies are required to confirm the shutdown margin and single rod reactivity fault. It should also be emphasized that no attempt was made to optimize the number and the arrangement of control assemblies. The number of control assemblies could be reduced by allowing a single rod worth bigger than 1$ with some means to limit the magnitude or speed of rod withdrawal.

The inventories of startup cores were estimated by replacing TRU fuel with weapons-grade plutonium (WG-Pu) fuel. The same core layout was used, but twelve fuel test assemblies were introduced as shown in Figure 3.2. As a result, the inner and middle core assemblies were reduced to 43 and 102, respectively. It was assumed that the test fuel assembly has the same dimension to the driver assembly but is composed of LWR-SF TRU. For the metal fuel, the Zr mass fraction was reduced to 10 % because of reduced TRU enrichment due to a high fissile content of WG-Pu. It was also assumed that the ABR spent fuel is not recycled.

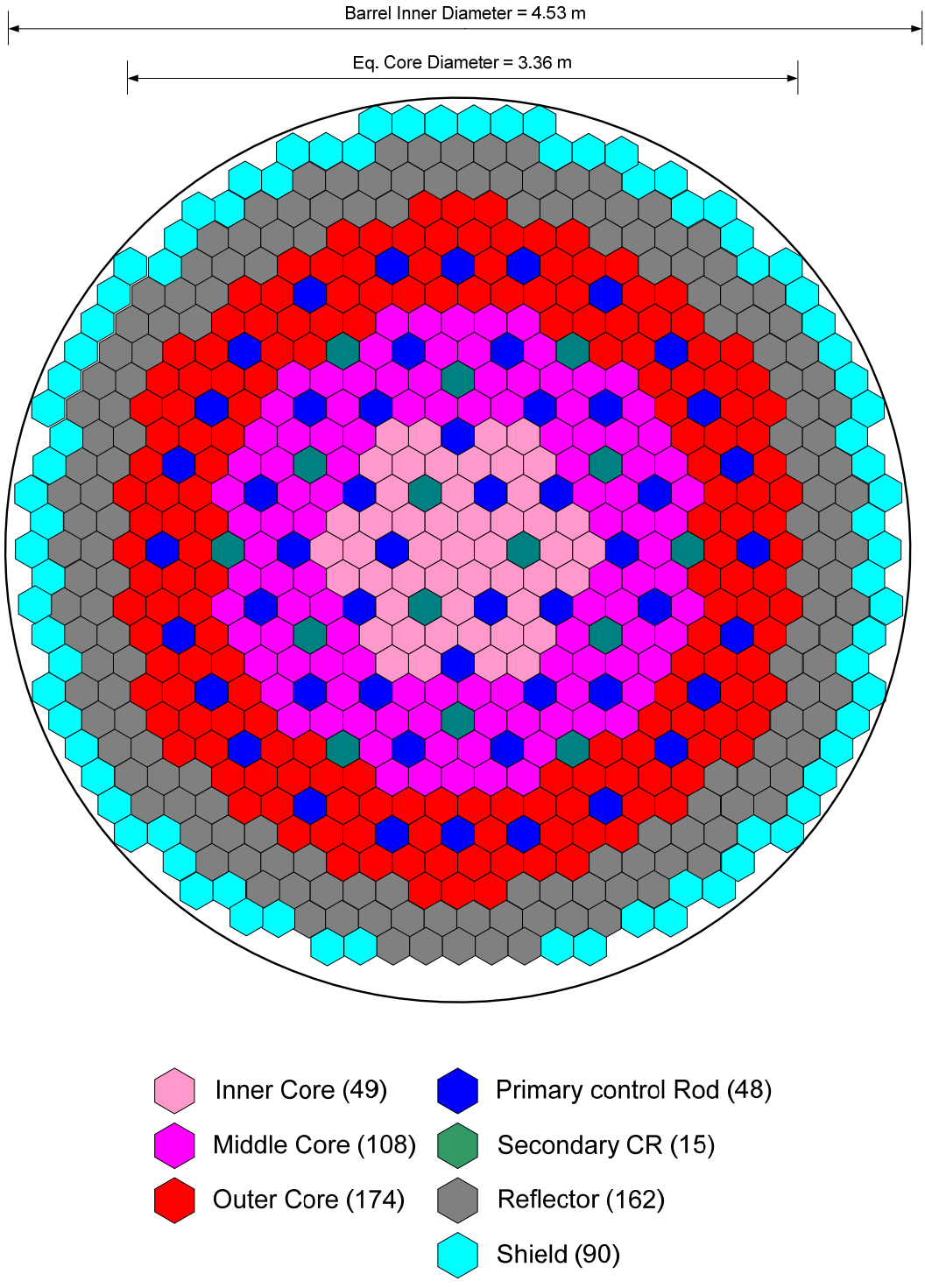

Figure 3.1 Recycled Core Planar Layout of a 2000 MWt ABR

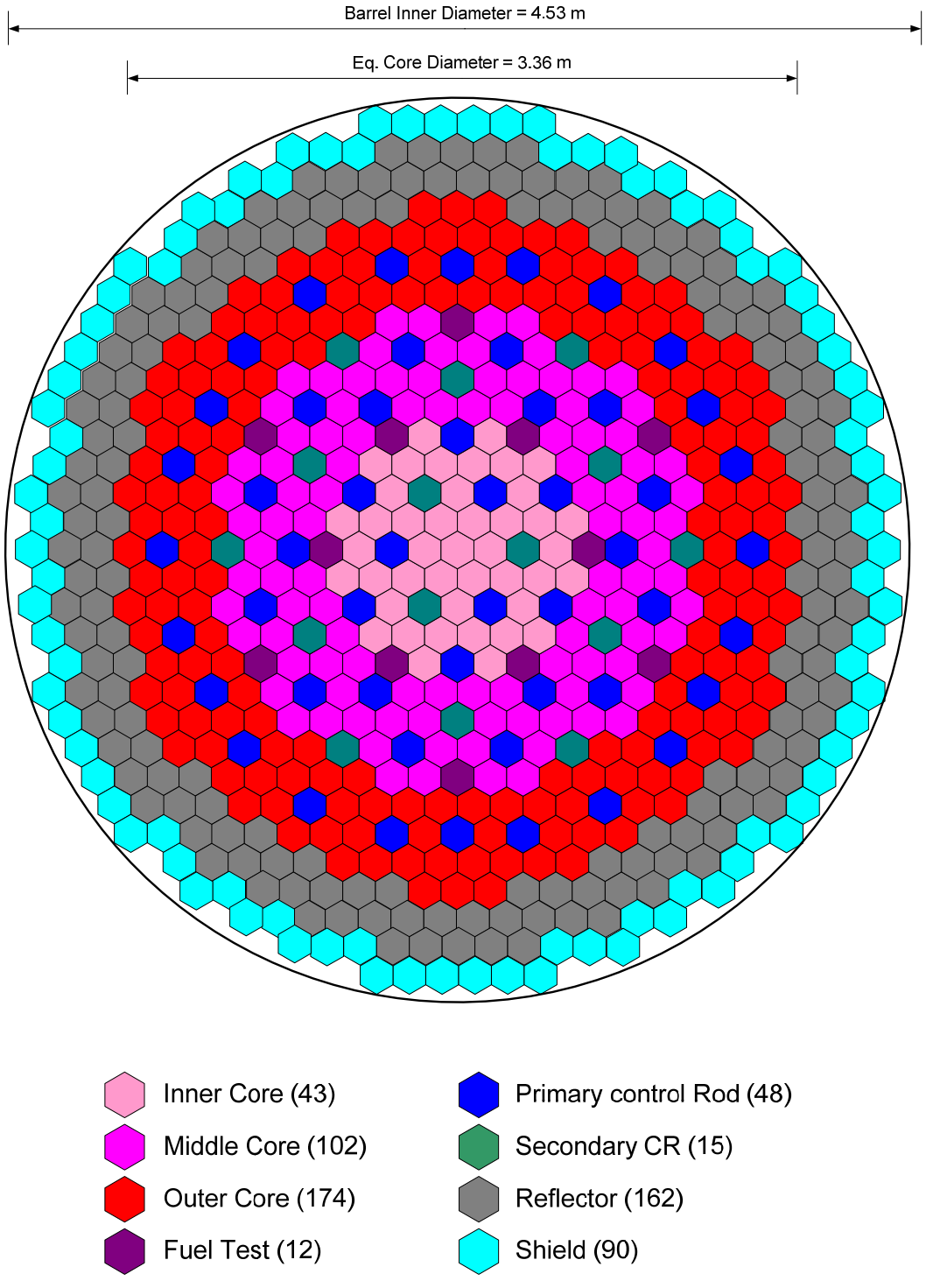

Figure 3.2 Startup Core Planar Layout of a 2000 MWt ABR

3.2. Assembly Designs

Figure 3.3 shows the schematics of fuel assembly and fuel pins. As-fabricated design parameters are presented in Table 3.1. Except for the fuel smeared density, the same design parameters were used for both metal and oxide fuels. The number of fuel pins per assembly is 397. The fuel pin diameter is 5.5 mm, and the cladding thickness is 0.70 mm. Active core height and gas plenum length are 102 cm and 191 cm, respectively.

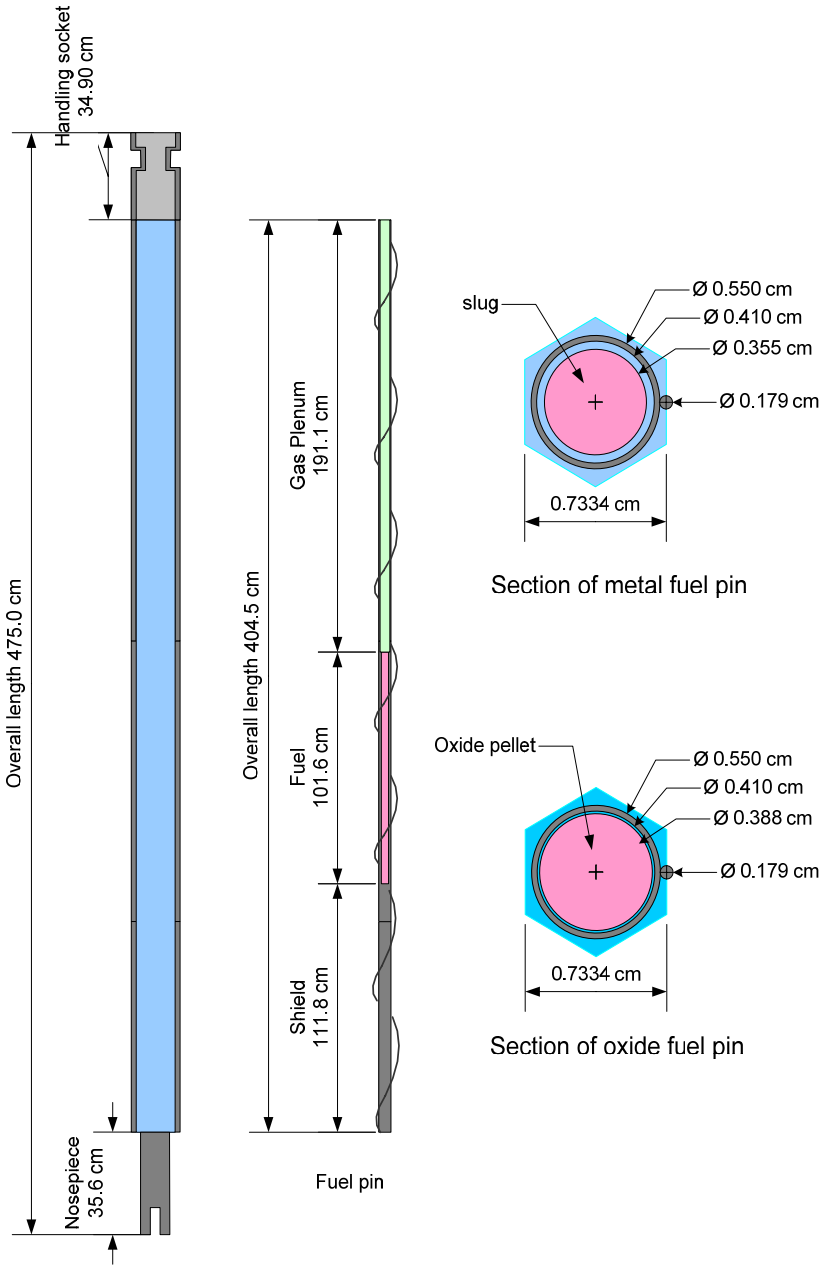

Figure 3.3 Schematics of Fuel Assembly and Fuel Pins

Table 3.1 Design Parameters of Metal and Oxide Fuel Assemblies

	Metal fuel	Oxide fuel
Assembly data		
- Number of fuel pins	397	397
- Assembly pitch, cm	16.142	16.142
- Inter-assembly gap, cm	0.432	0.432
- Duct inside flat-to-flat distance, cm	14.910	14.910
- Duct material	HT9	HT9
- Duct thickness, cm	0.400	0.400
Pin data		
- Fuel form	U-TRU-Zr	$(U,TRU)O_2$
- Bond material	Na	He
- Core / gas plenum height, cm	101.6 / 191.1	101.6 /191.1
- Overall pin length, cm	404.5	404.5
- Fuel smeared density, % TD	75.0	85.0
- Pin diameter, cm	0.550	0.550
- Pin pitch-to-diameter ratio	1.33	1.33
- Cladding thickness, cm	0.070	0.070
- Wire wrap diameter, cm	0.179	0.179
Volume fraction, %		
- Fuel	17.4	20.8
- Bond	5.8	2.4
- Structure	32.4	32.4
- Coolant	44.4	44.4

The 0.4 cm duct thickness and 0.42 cm inter-assembly gap were taken from the Super-PRISM design. The fuel pin is helically wrapped with wire to maintain the pin spacing so that the coolant can flow freely through the pin bundle. The helical pitch of the wire-wrap is 20.32 cm. The fuel smeared density is 75% for metal fuel and 85% TD (theoretical density) for mixed oxide fuel. The resulting fuel volume fraction is 17.4 % for metal fuel and 20.8 % for oxide fuel.

3.3. Equilibrium Cycle Performance Characteristics

The main core performance characteristics of the recycled metal and oxide fuel cores are summarized in Table 3.2, which were obtained from REBUS-3 equilibrium cycle calculations with recycling of ABR spent fuel. For both metal and oxide cores, the TRU enrichment was determined to meet the target cycle length of one-year. As aforementioned, the TRU recycled from ABR spent fuel was used as the primary TRU feed and the TRU recovered from LWR spent fuel was used as the make-up feed. Axial irradiation swelling of 5% was assumed for metal fuel, but the axial irradiation swelling of oxide fuel was neglected.

Table 3.2 Main Performance Parameters of Recycled Equilibrium Cores

	Metal fuel core	Oxide fuel core
Cycle length, months	12	12
Number of batches	3	3
Fuel form	U-TRU-20Zr	UO_2-$TRUO_2$
TRU enrichment (IC/MC/OC), %	42.2/47.7/52.7	41.8/47.2/52.2
Conversion ratio (fissile/TRU)	0.54 / 0.30	0.57 / 0.32
Initial core loading (HM/TRU), Mt	13.7 / 6.6	14.0 / 6.7
Specific power of active core, kW/kg	139	136
Power density of active core, kW/l	264	264
Discharge burnup (average/peak), MWd/kg	137 / 198	135 / 195
Peak fast fluence, 10^{23}/cm^2	2.91	2.59
Burnup reactivity swing (%Δk)	7.1	6.7
Power peaking factor, BOEC/EOEC	1.48 / 1.46	1.51 / 1.49
Peak linear power, kW/m	23.3	24.9
Linear power limit, kW/m	26.0	32.4
Core average flux, 10^{15}/cm^2-sec	3.72	3.53
Fast flux fraction (>0.1 MeV)	0.62	0.57

The metal and oxide cores have generally comparable performance characteristics for recycled equilibrium cycle. The heavy metal loading at the beginning of equilibrium cycle (BOEC) is about 13.7 MT for metal fuel core and 14.0 MT for oxide fuel core; the metal fuel core has a slightly smaller heavy metal loading because of smaller fuel volume fraction and relatively high Zr fraction. The smaller heavy metal loading of metal fuel core increases the required TRU enrichment slightly which in turn reduces the fissile and TRU conversion ratios. The TRU loading at BOEC is 6.6 MT for metal fuel core and 6.7 MT for oxide fuel core. The comparable heavy metal inventory resulted in similar specific power and average discharge burnup.

The neutron spectrum is softer in the oxide fuel core than in the metal fuel core, as indicated by the fast flux fraction (0.57 for the oxide fuel core vs. 0.62 for the metal fuel core). This results in a lower peak fast fluence in the oxide fuel core, despite its higher power peaking factor; it is 2.59×10^{23} n/cm^2 for the oxide fuel core and 2.91×10^{23} n/cm^2 for the metal fuel core. Since the peak fast fluence of both cores is less than the fast fluence limit of 4.0×10^{23} n/cm^2, the average discharge burnup could be increased further. However, no attempt was performed to increase the discharge burnup in this work because the peak discharge burnup is already beyond the

irradiation experience. The burnup reactivity swing is 0.4 %Δk higher in the metal fuel core because of a lower fissile conversion ratio. The peak linear power of the metal core is slightly lower than that of the oxide fuel core.

Table 3.3 compares the startup equilibrium cycle performance parameters of the metal and oxide fuel cores. As aforementioned, weapons-grade plutonium was used as TRU feed and the ABR spent fuel was not recycled. For the metal fuel core, the heavy metal loading of the startup core increased to 18.0 MT from 13.7 MT of the recycled core, since the Zr weight fraction was decreased to 10% from 20% without changing the core and assembly designs. On the other hand, the heavy metal loading of the oxide fuel core shows a minor variation due to the TRU feed change. The high fissile content of WG-Pu fuel reduced the required TRU enrichments of the startup cores significantly relative to the recycled cores. The TRU enrichment was reduced by ~40% for the oxide fuel core and by ~54% for the metal fuel core; the metal fuel core shows a higher reduction because of the significantly increased heavy metal loading. The TRU loading was reduced to 4.0 MT for both cores. The reduced TRU enrichment increased the TRU conversion ratio to 0.47 for the oxide fuel core and 0.59 for the metal fuel core. However, the fissile conversion ratio was reduced from 0.54 to 0.49 for the metal fuel core and from 0.57 to

Table 3.3 Main Performance Parameters of Startup Equilibrium Cores

	Metal fuel core	Oxide fuel core
Cycle length, months	12	12
Number of batches	3	3
Fuel form	U-TRU-10Zr	UO_2-$TRUO_2$
TRU enrichment (IC/MC/OC), %	19.4/21.9/24.3	25.6/28.9/32.0
Conversion ratio (fissile/TRU)	0.49 / 0.59	0.39 / 0.47
Initial core loading (HM/TRU), Mt	18.0 / 4.0	13.9 / 4.0
Specific power of active core, kW/kg	107	136
Power density of active core, kW/l	264	264
Discharge burnup (average/peak), MWd/kg	106 / 144	135 / 182
Peak fast fluence, $10^{23}/cm^2$	2.93	2.53
Burnup reactivity swing (%Δk)	7.7	10.3
Power peaking factor, BOEC/EOEC	1.48 / 1.38	1.43 / 1.37
Peak linear power, kW/m	22.9	24.7
Linear power limit, kW/m	25.2	33.4
Core average flux, $10^{15}/cm^2$-sec	3.62	3.59
Fast flux fraction (>0.1 MeV)	0.62	0.58

0.39 for the oxide fuel core. The reduced fissile conversion ratio in turn increased the burnup reactivity swing from 7.1 to 7.7 %Δk for the metal fuel core and from 6.7 to 10.3 %Δk for the oxide fuel core. The higher heavy metal loading of the metal fuel core resulted in lower specific power density and average discharge burnup relative to the oxide fuel core.

Table 3.4 summarizes the heavy metal mass flow rates of the recycled and startup cores, excluding the masses stored in the in-vessel storage. The mass flow rates of the startup cores include those of the fuel test assemblies. The annual heavy metal charge for the recycled core is 4.8 MT for the metal fuel core and 4.9 MT for the oxide fuel core. The TRU charge rate is 2.4 MT/year for both metal and oxide fuel cores. The TRU consumption rate is 457 kg/year for the

Table 3.4 Heavy Metal Mass Flow Rates (kg/year) of Recycled and Startup Cores

Isotope	Recycled Equilibrium Core				Start-up Core			
	Metal fuel		Oxide fuel		Metal fuel		Oxide fuel	
	charge	discharge	charge	discharge	charge	discharge	charge	discharge
U-234	0.0	1.4	0.0	1.4	0.0	0.0	0.0	0.0
U-235	4.8	2.4	4.9	2.5	9.5	4.7	6.7	3.1
U-236	0.0	0.7	0.0	0.7	0.0	1.0	0.0	0.8
U-238	2416.8	2197.6	2484.3	2249.0	4801.4	4381.7	3409.3	3074.5
NP237	39.5	23.4	36.6	21.0	1.7	2.3	1.8	1.8
Pu-236	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pu-238	84.8	75.3	85.1	75.7	0.7	1.8	0.7	1.9
Pu-239	807.9	560.9	806.0	567.9	1314.3	943.0	1357.6	870.3
Pu-240	794.1	687.3	803.8	700.5	91.0	197.3	94.0	224.3
Pu-241	157.7	130.1	163.8	138.1	8.7	18.8	9.0	23.8
Pu-242	233.2	211.1	236.3	214.9	2.7	4.0	2.7	4.7
Am-241	102.2	69.6	99.0	66.7	2.6	2.6	2.7	2.7
Am-242m	6.3	6.4	6.2	6.2	0.0	0.1	0.0	0.2
Am-243	74.1	70.3	75.2	71.6	0.4	0.6	0.4	0.7
Cm-242	0.6	5.8	0.6	5.9	0.0	0.2	0.0	0.3
Cm-243	0.5	0.6	0.6	0.6	0.0	0.0	0.0	0.0
Cm-244	50.2	53.2	55.0	58.2	0.0	0.2	0.0	0.2
Cm-245	14.4	14.4	16.7	16.7	0.0	0.0	0.0	0.0
Cm-246	8.9	8.9	10.7	10.7	0.0	0.0	0.0	0.0
TRU	2374.3	1917.0	2395.7	1954.8	1422.1	1171.0	1468.9	1130.9
Total HM	4795.8	4119.2	4884.9	4208.4	6233.0	5558.5	4884.9	4209.4

metal fuel core and 441 kg/year for the oxide fuel core. Compared to the recycled core, the annual heavy metal charge rate of the startup core was increased to 6.2 MT for the metal fuel core because of the reduced Zr fraction, while it was unchanged for the oxide fuel core. The annual TRU charge rate was decreased to 1.4 MT for the metal fuel core and 1.5 MT for the oxide fuel core. Because of higher TRU conversion ratios, the TRU consumption rate was reduced to 251.1 kg/year for the metal fuel core and 338.0 kg/year for the oxide fuel core.

4. Core Inventories of 2000 MWt ABR

4.1. Isotopic Mass

Detailed isotopic inventories were estimated by REBUS-3/ORIGEN-2 coupled calculations. Using the REBUS-3 calculations, effective one-group cross sections of actinide isotopes were separately generated for inner, middle, and outer cores. With these actinide cross sections and the FFTF cross sections for other isotopes (included in the ORIGEN-2 code package), ORIGEN-2 calculations were performed for the fresh fuel compositions of inner, middle, and outer cores. In these calculations, one-month refueling time between irradiation cycles was assumed. The equilibrium cycle fresh fuel composition in each core region was obtained from the REBUS-3 equilibrium cycle calculations. For the startup cores, the target assemblies were not represented in the ORIGEN-2 calculation set to minimize the number of cases and approximated using inner and middle core drivers (6 for inner core and 6 for middle core): thus, the minor actinide masses were slightly smaller than those obtained from the REBUS-3 calculations.

The calculated isotopic masses at the beginning of equilibrium cycle (BOEC) and the end of equilibrium cycle (EOEC) are summarized in Tables 4.1 to 4.12 for heavy metal nuclides, leading radioactive fission products, and specified activation products [13]. The isotopic masses of inner, middle, and outer cores are separately presented along with those of the spent fuel assemblies stored in the in-vessel storage. It was assumed that a whole batch of discharged fuel assemblies was stored in the in-vessel storage for an entire irradiation cycle. The isotopic masses of inner, middle, and outer cores represent the batch-averaged values; the BOEC masses are the average values of the isotopic masses of fresh, once-burned, and twice-burned fuel assemblies, and the EOEC masses are the average values of the isotopic masses of once-burned, twice-burned, and thrice-burned fuel assemblies. The in-vessel storage masses are the total isotopic masses of all the spent fuel assemblies discharged from inner, middle, and outer cores. Because of the assumed one-month refueling time, the values at BOEC are the isotopic masses one month after reactor shutdown, and the in-vessel storage masses at EOEC are the isotopic masses of additional one-year cooled spent fuel assemblies. Thus, if the decay of long-lived heavy metal nuclides is neglected for one-month refueling time, the in-vessel storage masses at BOEC should be comparable to the discharge masses determined from the REBUS-3 equilibrium cycle calculations. By comparing the in-vessel storage masses at BOEC to the discharge masses of Table 3.4, it was confirmed that the ORIGEN-2 and REBUS-3 calculations yielded consistent depletion results for actinide isotopes.

For the recycled cores, it can be seen that the inventories including the spent fuel stored in in-vessel storage are comparable for metal and oxide fuel cores. The total heavy metal mass at BOEC is 17.8 MT for the metal fuel core and 18.1 MT for the oxide fuel core. The TRU inventory is about 8.5 MT for the metal core and 8.7 MT for the oxide core. Since the same thermal power is produced, the total fission product inventories at BOEC and EOEC are the same for both metal and oxide cores as 1.4 MT and 2.0 MT, respectively.

Table 4.1 Actinide Mass (kg) of Recycled Metal Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
U234	0.2	0.5	1.0	1.6	3.3	0.4	1.0	1.8	2.1	5.3
U235	1.9	3.9	6.0	2.5	14.3	1.5	2.9	5.0	2.5	11.9
U236	0.1	0.3	0.4	0.7	1.6	0.3	0.6	0.7	0.8	2.3
U237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U238	1188.9	2372.9	3491.2	2197.8	9250.8	1144.3	2283.5	3399.9	2197.8	9025.5
U239	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.8E-03	5.7E-03	5.7E-03	0.0E+00	1.4E-02
Np237	12.3	30.7	57.9	22.9	123.8	9.8	24.6	49.7	23.0	107.2
Np238	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
Np239	0.0	0.0	0.0	0.0	0.0	0.4	0.8	0.8	0.0	2.0
Pu238	30.8	76.2	137.7	75.3	319.9	29.1	71.6	132.2	78.7	311.5
Pu239	274.0	666.2	1216.6	555.9	2712.8	243.9	576.5	1079.9	555.9	2456.2
Pu240	287.3	712.8	1288.2	688.3	2976.6	272.5	672.3	1235.3	690.2	2870.4
Pu241	56.0	138.4	248.5	129.0	571.9	52.6	129.1	233.8	123.4	538.9
Pu242	85.6	212.6	382.2	211.1	891.4	82.4	204.3	370.9	211.1	868.7
Pu243	1.4E-13	3.2E-13	2.8E-13	1.3E-12	2.1E-12	4.1E-03	1.0E-02	1.3E-02	1.3E-12	2.7E-02
Am241	33.7	84.1	158.9	72.1	348.8	28.7	71.6	144.6	77.5	322.3
Am242m	2.5	6.1	11.0	6.2	25.8	2.4	6.0	11.0	6.2	25.6
Am242	2.0E-05	4.9E-05	8.9E-05	7.4E-05	2.3E-04	1.4E-02	3.5E-02	4.7E-02	7.4E-05	9.6E-02
Am243	27.6	68.6	123.2	70.5	289.9	27.1	67.1	121.5	70.5	286.2
Am244	1.9E-24	4.6E-24	5.6E-24	6.7E-24	1.9E-23	8.5E-03	2.1E-02	2.5E-02	0.0E+00	5.4E-02
Cm242	1.6	3.8	5.1	5.3	15.9	2.6	6.3	8.5	1.3	18.6
Cm243	0.2	0.5	0.8	0.5	2.1	0.2	0.5	0.8	0.5	2.1
Cm244	19.8	48.9	85.3	53.2	207.1	20.5	50.4	86.3	51.3	208.6
Cm245	5.5	13.6	24.1	14.5	57.7	5.6	13.7	24.0	14.5	57.7
Total	2028.2	4440.8	7238.4	4109.2	17816.5	1925.0	4184.0	6908.5	4109.2	17126.7
TRU	836.8	2062.6	3739.6	1904.8	8543.7	778.0	1894.8	3499.4	1904.1	8076.3

Table 4.2 Fission Product Mass (kg) of Recycled Metal Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
Total	102.3	254.1	326.4	682.8	1365.6	204.6	508.2	652.8	682.8	2048.4
XE135	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.81E-03	1.68E-02	2.17E-02	0.00E+00	4.54E-02
I134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.44E-04	1.59E-03	2.05E-03	0.00E+00	4.29E-03
RU103	1.98E-01	4.92E-01	6.31E-01	6.81E-01	2.00E+00	5.11E-01	1.27E+00	1.62E+00	1.84E-03	3.40E+00
XE133	1.34E-03	3.31E-03	4.27E-03	4.50E-03	1.34E-02	8.67E-02	2.14E-01	2.76E-01	2.59E-22	5.76E-01
I133	3.64E-13	8.98E-13	1.16E-12	1.21E-12	3.64E-12	1.41E-02	3.47E-02	4.48E-02	0.00E+00	9.36E-02
TC103	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.21E-06	1.78E-05	2.30E-05	0.00E+00	4.81E-05
TC102	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.44E-07	1.84E-06	2.37E-06	0.00E+00	4.96E-06
MO102	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.37E-05	2.31E-04	2.99E-04	0.00E+00	6.24E-04
I135	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.41E-03	1.09E-02	1.41E-02	0.00E+00	2.94E-02
MO103	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.47E-06	2.09E-05	2.71E-05	0.00E+00	5.64E-05
TC104	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.56E-04	3.85E-04	4.98E-04	0.00E+00	1.04E-03
TC101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-04	2.93E-04	3.77E-04	0.00E+00	7.90E-04
MO101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-04	3.02E-04	3.88E-04	0.00E+00	8.13E-04
CS138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.48E-04	8.61E-04	1.11E-03	0.00E+00	2.32E-03
ZR 95	2.49E-01	6.17E-01	7.95E-01	8.40E-01	2.50E+00	5.19E-01	1.29E+00	1.66E+00	2.22E-02	3.48E+00
SR 90	7.92E-01	1.96E+00	2.51E+00	5.18E+00	1.04E+01	1.57E+00	3.90E+00	5.00E+00	5.07E+00	1.55E+01
Y 90	1.99E-04	4.92E-04	6.31E-04	1.30E-03	2.62E-03	4.32E-04	1.07E-03	1.34E-03	1.27E-03	4.12E-03
CS137	3.62E+00	9.01E+00	1.16E+01	2.38E+01	4.81E+01	7.20E+00	1.79E+01	2.30E+01	2.33E+01	7.15E+01
BA139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.50E-04	2.10E-03	2.71E-03	0.00E+00	5.65E-03
BA140	2.30E-02	5.68E-02	7.34E-02	7.67E-02	2.30E-01	1.76E-01	4.34E-01	5.60E-01	9.86E-10	1.17E+00
CE141	1.63E-01	4.04E-01	5.21E-01	5.45E-01	1.63E+00	4.62E-01	1.14E+00	1.47E+00	4.29E-04	3.08E+00
CE143	2.88E-09	7.11E-09	9.18E-09	9.64E-09	2.88E-08	1.59E-02	3.93E-02	5.06E-02	0.00E+00	1.06E-01
CE144	1.18E+00	2.93E+00	3.76E+00	5.17E+00	1.30E+01	2.10E+00	5.22E+00	6.71E+00	2.28E+00	1.63E+01
CS134	1.26E-01	3.22E-01	2.96E-01	1.26E+00	2.00E+00	3.46E-01	8.93E-01	8.20E-01	9.25E-01	2.98E+00
CS136	8.47E-04	2.13E-03	2.45E-03	3.87E-03	9.30E-03	7.16E-03	1.82E-02	2.02E-02	7.68E-11	4.55E-02

Table 4.2 Fission Product Mass (kg) of Recycled Metal Fuel Core (continued)

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
I131	3.89E-03	9.60E-03	1.24E-02	1.30E-02	3.89E-02	7.51E-02	1.86E-01	2.40E-01	3.64E-15	5.00E-01
I132	1.39E-06	3.42E-06	4.43E-06	4.62E-06	1.39E-05	1.22E-03	3.01E-03	3.88E-03	0.00E+00	8.11E-03
KR 85	4.49E-02	1.11E-01	1.42E-01	2.90E-01	5.88E-01	8.89E-02	2.21E-01	2.82E-01	2.73E-01	8.64E-01
KR 85M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.68E-04	4.12E-04	5.33E-04	0.00E+00	1.11E-03
KR 87	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.10E-05	1.99E-04	2.56E-04	0.00E+00	5.36E-04
KR 88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.52E-04	6.19E-04	7.97E-04	0.00E+00	1.67E-03
LA140	3.47E-03	8.57E-03	1.11E-02	1.16E-02	3.47E-02	2.33E-02	5.75E-02	7.40E-02	1.49E-10	1.55E-01
LA141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.30E-03	5.67E-03	7.33E-03	0.00E+00	1.53E-02
LA142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.03E-04	1.98E-03	2.56E-03	0.00E+00	5.35E-03
MO 99	1.03E-05	2.55E-05	3.27E-05	3.48E-05	1.03E-04	2.99E-02	7.39E-02	9.48E-02	0.00E+00	1.99E-01
NB 95	1.74E-01	4.31E-01	5.55E-01	5.91E-01	1.75E+00	2.81E-01	6.96E-01	8.96E-01	2.65E-02	1.90E+00
ND147	6.59E-03	1.63E-02	2.08E-02	2.25E-02	6.62E-02	6.54E-02	1.62E-01	2.06E-01	1.69E-11	4.33E-01
PR143	2.50E-02	6.18E-02	7.98E-02	8.38E-02	2.51E-01	1.57E-01	3.87E-01	4.98E-01	3.05E-09	1.04E+00
RB 86	9.53E-05	2.44E-04	2.26E-04	6.33E-04	1.20E-03	6.14E-04	1.59E-03	1.45E-03	2.47E-09	3.65E-03
RH105	8.40E-09	2.08E-08	2.67E-08	2.87E-08	8.46E-08	1.49E-02	3.70E-02	4.73E-02	0.00E+00	9.92E-02
RU105	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.88E-03	4.67E-03	5.96E-03	0.00E+00	1.25E-02
RU106	1.24E+00	3.09E+00	3.98E+00	5.84E+00	1.41E+01	2.24E+00	5.56E+00	7.17E+00	3.11E+00	1.81E+01
SB127	1.49E-05	3.68E-05	4.73E-05	4.97E-05	1.49E-04	4.90E-03	1.21E-02	1.55E-02	3.02E-31	3.25E-02
SB129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.85E-04	1.44E-03	1.86E-03	0.00E+00	3.89E-03
SR 89	6.53E-02	1.61E-01	2.07E-01	2.18E-01	6.51E-01	1.48E-01	3.65E-01	4.69E-01	2.18E-03	9.85E-01
SR 91	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.62E-03	3.98E-03	5.13E-03	0.00E+00	1.07E-02
SR 92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.57E-04	1.37E-03	1.77E-03	0.00E+00	3.70E-03
TC 99M	9.05E-07	2.24E-06	2.88E-06	3.06E-06	9.08E-06	2.39E-03	5.90E-03	7.57E-03	0.00E+00	1.59E-02

Table 4.2 Fission Product Mass (kg) of Recycled Metal Fuel Core (continued)

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
TE127	3.69E-05	9.13E-05	1.18E-04	1.30E-04	3.75E-04	4.91E-04	1.21E-03	1.56E-03	1.48E-05	3.27E-03
TE127M	1.01E-02	2.51E-02	3.23E-02	3.57E-02	1.03E-01	1.80E-02	4.46E-02	5.74E-02	4.23E-03	1.24E-01
TE129	5.49E-06	1.36E-05	1.76E-05	1.83E-05	5.50E-05	1.56E-04	3.86E-04	4.96E-04	1.82E-08	1.04E-03
TE129M	5.87E-03	1.45E-02	1.88E-02	1.96E-02	5.87E-02	1.63E-02	4.03E-02	5.20E-02	1.94E-05	1.09E-01
TE131M	7.00E-11	1.73E-10	2.25E-10	2.33E-10	7.01E-10	1.75E-03	4.33E-03	5.62E-03	0.00E+00	1.17E-02
TE132	4.58E-05	1.13E-04	1.46E-04	1.52E-04	4.57E-04	4.05E-02	1.00E-01	1.29E-01	0.00E+00	2.70E-01
Y 91	1.13E-01	2.79E-01	3.58E-01	3.78E-01	1.13E+00	2.40E-01	5.94E-01	7.63E-01	7.12E-03	1.60E+00
Y 92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.36E-04	1.81E-03	2.34E-03	0.00E+00	4.88E-03
Y 93	6.28E-25	1.55E-24	2.00E-24	2.09E-24	6.26E-24	2.68E-03	6.61E-03	8.54E-03	0.00E+00	1.78E-02
ZR 97	6.39E-16	1.58E-15	2.03E-15	2.14E-15	6.39E-15	6.42E-03	1.58E-02	2.04E-02	0.00E+00	4.27E-02
Others	9.42E+01	2.34E+02	3.01E+02	6.38E+02	1.27E+03	1.88E+02	4.67E+02	6.00E+02	6.48E+02	1.90E+03

Table 4.3 Activation Product Mass (kg) of Recycled Metal Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
Total	17865.4	39384.6	63465.7	40238.6	160954.3	17865.4	39384.6	63465.7	40238.6	160954.3
RU103	7.19E-06	1.72E-05	9.91E-06	8.16E-05	1.16E-04	4.06E-05	9.99E-05	5.62E-05	2.20E-07	1.97E-04
TC101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.26E-06	1.21E-05	1.36E-05	0.00E+00	3.09E-05
MO101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.41E-06	1.24E-05	1.40E-05	0.00E+00	3.18E-05
ZR 95	2.68E-02	6.08E-02	6.92E-02	9.05E-02	2.47E-01	5.83E-02	1.33E-01	1.51E-01	2.40E-03	3.45E-01
SR 90	3.33E-07	7.70E-07	6.25E-07	3.24E-06	4.97E-06	9.54E-07	2.24E-06	1.79E-06	3.17E-06	8.15E-06
Y 90	1.65E-08	3.76E-08	4.26E-08	5.59E-08	1.53E-07	6.28E-05	1.44E-04	1.62E-04	7.96E-10	3.69E-04
MO 99	1.64E-06	3.72E-06	4.22E-06	5.50E-06	1.51E-05	4.94E-03	1.13E-02	1.27E-02	0.00E+00	2.90E-02
NB 95	1.86E-02	4.21E-02	4.80E-02	6.31E-02	1.72E-01	3.11E-02	7.12E-02	8.05E-02	2.86E-03	1.86E-01
RH105	2.05E-17	5.21E-17	1.49E-17	3.95E-16	4.82E-16	1.29E-10	3.45E-10	9.37E-11	0.00E+00	5.68E-10
RU105	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.62E-11	4.36E-11	1.18E-11	0.00E+00	7.17E-11
RU106	3.37E-14	8.80E-14	1.77E-14	9.47E-13	1.09E-12	2.67E-13	7.42E-13	1.41E-13	5.04E-13	1.65E-12
SR 89	1.35E-05	3.06E-05	3.47E-05	4.56E-05	1.24E-04	3.20E-05	7.34E-05	8.24E-05	4.58E-07	1.88E-04
SR 91	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.95E-08	1.14E-07	1.28E-07	0.00E+00	2.91E-07
Y 91	4.30E-05	9.76E-05	1.11E-04	1.46E-04	3.97E-04	9.66E-05	2.21E-04	2.48E-04	2.75E-06	5.69E-04
Y 92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.11E-07	4.85E-07	5.44E-07	0.00E+00	1.24E-06
Y 93	4.15E-32	9.43E-32	1.07E-31	1.39E-31	3.82E-31	1.85E-10	4.24E-10	4.78E-10	0.00E+00	1.09E-09
ZR 97	2.10E-17	4.76E-17	5.42E-17	7.01E-17	1.93E-16	2.19E-04	5.03E-04	5.66E-04	0.00E+00	1.29E-03
Others	17865.3	39384.5	63465.6	40238.4	160953.9	17865.3	39384.4	63465.5	40238.6	160953.7

Table 4.4 Actinide Mass (kg) of Recycled Oxide Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
U234	0.2	0.5	1.0	1.6	3.3	0.4	1.0	1.8	2.1	5.3
U235	2.0	3.9	6.2	2.5	14.6	1.5	3.0	5.1	2.5	12.1
U236	0.2	0.3	0.4	0.8	1.7	0.3	0.6	0.8	0.8	2.5
U237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U238	1218.8	2433.6	3588.4	2249.8	9490.7	1172.7	2337.6	3489.2	2249.8	9249.3
U239	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.0E-03	6.1E-03	6.2E-03	0.0E+00	1.5E-02
Np237	11.3	28.1	53.2	20.6	113.2	9.0	22.2	45.2	20.7	97.1
Np238	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
Np239	0.0	0.0	0.0	0.0	0.0	0.4	0.9	0.9	0.0	2.2
Pu238	30.9	76.5	138.2	75.7	321.3	29.4	71.9	132.6	79.1	313.0
Pu239	276.0	668.2	1216.4	563.1	2723.7	248.2	582.1	1082.7	563.1	2476.1
Pu240	292.2	723.7	1306.0	701.7	3023.7	278.5	684.5	1254.2	703.7	2920.9
Pu241	58.8	145.2	259.8	137.1	600.8	55.8	136.6	245.8	131.1	569.4
Pu242	86.9	215.8	387.6	215.0	905.3	84.0	207.8	376.6	215.0	883.4
Pu243	1.8E-13	4.4E-13	4.0E-13	1.8E-12	2.8E-12	4.4E-03	1.1E-02	1.4E-02	1.8E-12	3.0E-02
Am241	32.7	81.1	153.6	69.3	336.8	27.9	68.7	139.2	75.1	310.9
Am242m	2.4	6.0	10.7	6.0	25.1	2.4	5.8	10.8	6.0	25.0
Am242	1.9E-05	4.8E-05	8.7E-05	7.2E-05	2.3E-04	1.4E-02	3.6E-02	4.9E-02	7.2E-05	9.9E-02
Am243	28.1	69.8	125.3	71.8	295.0	27.6	68.3	123.6	71.8	291.4
Am244	2.0E-24	5.1E-24	6.3E-24	7.5E-24	2.1E-23	9.1E-03	2.3E-02	2.8E-02	0.0E+00	6.0E-02
Cm242	1.6	4.0	5.3	5.4	16.3	2.6	6.4	8.8	1.3	19.1
Cm243	0.2	0.6	1.0	0.6	2.4	0.2	0.6	0.9	0.6	2.4
Cm244	21.6	53.6	93.5	58.2	226.9	22.4	55.2	94.6	56.2	228.5
Cm245	6.4	15.8	27.9	16.8	66.9	6.5	15.9	27.8	16.8	66.9
Total	2070.7	4527.6	7375.6	4198.0	18171.9	1970.5	4270.8	7042.6	4198.0	17481.8
TRU	849.3	2088.3	3778.5	1941.3	8657.4	794.9	1927.1	3543.9	1940.6	8206.5

Table 4.5 Fission Product Mass (kg) of Recycled Oxide Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
Total	99.4	254.3	329.5	683.3	1366.5	198.9	508.8	658.9	683.3	2049.8
XE135	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.63E-03	1.69E-02	2.19E-02	0.00E+00	4.54E-02
I134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.29E-04	1.60E-03	2.08E-03	0.00E+00	4.30E-03
RU103	1.92E-01	4.92E-01	6.36E-01	6.79E-01	2.00E+00	4.95E-01	1.27E+00	1.63E+00	1.83E-03	3.40E+00
XE133	1.30E-03	3.32E-03	4.31E-03	4.50E-03	1.34E-02	8.43E-02	2.14E-01	2.78E-01	2.59E-22	5.77E-01
I133	3.54E-13	9.00E-13	1.17E-12	1.21E-12	3.64E-12	1.37E-02	3.48E-02	4.53E-02	0.00E+00	9.37E-02
TC103	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.01E-06	1.78E-05	2.33E-05	0.00E+00	4.81E-05
TC102	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.25E-07	1.84E-06	2.40E-06	0.00E+00	4.96E-06
MO102	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.12E-05	2.32E-04	3.02E-04	0.00E+00	6.25E-04
I135	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.30E-03	1.09E-02	1.42E-02	0.00E+00	2.94E-02
MO103	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.24E-06	2.10E-05	2.73E-05	0.00E+00	5.65E-05
TC104	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.52E-04	3.86E-04	5.03E-04	0.00E+00	1.04E-03
TC101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.15E-04	2.94E-04	3.81E-04	0.00E+00	7.90E-04
MO101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-04	3.02E-04	3.92E-04	0.00E+00	8.13E-04
CS138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.39E-04	8.62E-04	1.12E-03	0.00E+00	2.32E-03
ZR 95	2.42E-01	6.17E-01	8.01E-01	8.39E-01	2.50E+00	5.04E-01	1.29E+00	1.67E+00	2.22E-02	3.48E+00
SR 90	7.68E-01	1.96E+00	2.53E+00	5.17E+00	1.04E+01	1.53E+00	3.89E+00	5.03E+00	5.06E+00	1.55E+01
Y 90	1.93E-04	4.91E-04	6.36E-04	1.30E-03	2.62E-03	4.16E-04	1.07E-03	1.35E-03	1.27E-03	4.10E-03
CS137	3.52E+00	9.01E+00	1.17E+01	2.38E+01	4.81E+01	7.00E+00	1.79E+01	2.32E+01	2.33E+01	7.15E+01
BA139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.28E-04	2.10E-03	2.74E-03	0.00E+00	5.67E-03
BA140	2.24E-02	5.70E-02	7.43E-02	7.69E-02	2.31E-01	1.71E-01	4.35E-01	5.66E-01	9.89E-10	1.17E+00
CE141	1.58E-01	4.04E-01	5.25E-01	5.45E-01	1.63E+00	4.48E-01	1.14E+00	1.49E+00	4.29E-04	3.08E+00
CE143	2.80E-09	7.12E-09	9.26E-09	9.65E-09	2.88E-08	1.55E-02	3.93E-02	5.11E-02	0.00E+00	1.06E-01
CE144	1.15E+00	2.93E+00	3.80E+00	5.18E+00	1.31E+01	2.05E+00	5.23E+00	6.78E+00	2.29E+00	1.63E+01
CS134	1.12E-01	3.07E-01	2.90E-01	1.20E+00	1.90E+00	3.08E-01	8.49E-01	8.01E-01	8.79E-01	2.84E+00
CS136	7.89E-04	2.07E-03	2.43E-03	3.72E-03	9.02E-03	6.61E-03	1.76E-02	1.99E-02	7.38E-11	4.41E-02

Table 4.5 Fission Product Mass (kg) of Recycled Oxide Fuel Core (continued)

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
I131	3.78E-03	9.61E-03	1.25E-02	1.30E-02	3.89E-02	7.31E-02	1.86E-01	2.42E-01	3.64E-15	5.01E-01
I132	1.35E-06	3.43E-06	4.46E-06	4.63E-06	1.39E-05	1.19E-03	3.01E-03	3.92E-03	0.00E+00	8.12E-03
KR 85	4.34E-02	1.11E-01	1.43E-01	2.88E-01	5.86E-01	8.59E-02	2.20E-01	2.83E-01	2.72E-01	8.60E-01
KR 85M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.63E-04	4.12E-04	5.36E-04	0.00E+00	1.11E-03
KR 87	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.89E-05	1.99E-04	2.59E-04	0.00E+00	5.37E-04
KR 88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.45E-04	6.20E-04	8.05E-04	0.00E+00	1.67E-03
LA140	3.38E-03	8.60E-03	1.12E-02	1.16E-02	3.48E-02	2.27E-02	5.76E-02	7.48E-02	1.49E-10	1.55E-01
LA141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.23E-03	5.67E-03	7.39E-03	0.00E+00	1.53E-02
LA142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.82E-04	1.99E-03	2.58E-03	0.00E+00	5.35E-03
MO 99	1.00E-05	2.55E-05	3.31E-05	3.48E-05	1.03E-04	2.91E-02	7.40E-02	9.58E-02	0.00E+00	1.99E-01
NB 95	1.69E-01	4.31E-01	5.59E-01	5.90E-01	1.75E+00	2.72E-01	6.95E-01	9.03E-01	2.65E-02	1.90E+00
ND147	6.41E-03	1.63E-02	2.11E-02	2.25E-02	6.63E-02	6.37E-02	1.62E-01	2.09E-01	1.69E-11	4.34E-01
PR143	2.44E-02	6.19E-02	8.06E-02	8.40E-02	2.51E-01	1.52E-01	3.87E-01	5.03E-01	3.05E-09	1.04E+00
RB 86	8.46E-05	2.31E-04	2.20E-04	5.95E-04	1.13E-03	5.41E-04	1.50E-03	1.41E-03	2.32E-09	3.45E-03
RH105	8.18E-09	2.09E-08	2.70E-08	2.88E-08	8.48E-08	1.45E-02	3.71E-02	4.78E-02	0.00E+00	9.94E-02
RU105	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.83E-03	4.68E-03	6.03E-03	0.00E+00	1.25E-02
RU106	1.21E+00	3.10E+00	4.03E+00	5.86E+00	1.42E+01	2.18E+00	5.59E+00	7.26E+00	3.12E+00	1.81E+01
SB127	1.45E-05	3.68E-05	4.78E-05	4.98E-05	1.49E-04	4.77E-03	1.21E-02	1.57E-02	3.02E-31	3.26E-02
SB129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.69E-04	1.45E-03	1.88E-03	0.00E+00	3.90E-03
SR 89	6.34E-02	1.61E-01	2.09E-01	2.17E-01	6.50E-01	1.44E-01	3.65E-01	4.73E-01	2.18E-03	9.84E-01
SR 91	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.57E-03	3.98E-03	5.17E-03	0.00E+00	1.07E-02
SR 92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.41E-04	1.37E-03	1.78E-03	0.00E+00	3.70E-03
TC 99M	8.81E-07	2.24E-06	2.91E-06	3.06E-06	9.09E-06	2.32E-03	5.91E-03	7.65E-03	0.00E+00	1.59E-02

Table 4.5 Fission Product Mass (kg) of Recycled Oxide Fuel Core (continued)

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
TE127	3.59E-05	9.15E-05	1.19E-04	1.30E-04	3.76E-04	4.78E-04	1.21E-03	1.57E-03	1.48E-05	3.28E-03
TE127M	9.87E-03	2.51E-02	3.26E-02	3.57E-02	1.03E-01	1.76E-02	4.47E-02	5.80E-02	4.24E-03	1.25E-01
TE129	5.34E-06	1.36E-05	1.77E-05	1.83E-05	5.49E-05	1.52E-04	3.87E-04	5.01E-04	1.82E-08	1.04E-03
TE129M	5.70E-03	1.45E-02	1.89E-02	1.96E-02	5.87E-02	1.58E-02	4.03E-02	5.24E-02	1.94E-05	1.08E-01
TE131M	6.78E-11	1.73E-10	2.26E-10	2.32E-10	6.99E-10	1.70E-03	4.32E-03	5.65E-03	0.00E+00	1.17E-02
TE132	4.46E-05	1.13E-04	1.47E-04	1.53E-04	4.58E-04	3.95E-02	1.00E-01	1.31E-01	0.00E+00	2.70E-01
Y 91	1.09E-01	2.78E-01	3.61E-01	3.77E-01	1.13E+00	2.33E-01	5.93E-01	7.68E-01	7.11E-03	1.60E+00
Y 92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.15E-04	1.81E-03	2.36E-03	0.00E+00	4.88E-03
Y 93	6.11E-25	1.55E-24	2.02E-24	2.09E-24	6.26E-24	2.61E-03	6.61E-03	8.61E-03	0.00E+00	1.78E-02
ZR 97	6.21E-16	1.58E-15	2.05E-15	2.14E-15	6.39E-15	6.24E-03	1.59E-02	2.06E-02	0.00E+00	4.27E-02
Others	9.16E+01	2.34E+02	3.04E+02	6.38E+02	1.27E+03	1.83E+02	4.68E+02	6.06E+02	6.48E+02	1.90E+03

Table 4.6 Activation Product Mass (kg) of Recycled Oxide Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
Total	17274.1	38081.1	61365.2	38905.2	155625.6	17273.4	38079.5	61362.6	38905.2	155620.7
RU103	5.52E-06	1.48E-05	9.00E-06	6.90E-05	9.83E-05	3.08E-05	8.53E-05	5.08E-05	1.86E-07	1.67E-04
TC101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.79E-06	1.14E-05	1.32E-05	0.00E+00	2.94E-05
MO101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.93E-06	1.18E-05	1.35E-05	0.00E+00	3.02E-05
ZR 95	6.41E-06	1.51E-05	1.75E-05	2.29E-05	6.19E-05	1.40E-05	3.35E-05	3.82E-05	6.05E-07	8.63E-05
SR 90	1.16E-10	2.90E-10	2.38E-10	1.34E-09	1.99E-09	3.55E-10	9.08E-10	7.28E-10	1.31E-09	3.30E-09
Y 90	1.64E-13	4.12E-13	3.42E-13	1.24E-12	2.16E-12	7.12E-10	1.83E-09	1.50E-09	3.29E-13	4.05E-09
MO 99	1.50E-06	3.53E-06	4.08E-06	5.19E-06	1.43E-05	4.49E-03	1.07E-02	1.23E-02	0.00E+00	2.75E-02
NB 95	8.19E-06	1.94E-05	2.22E-05	2.97E-05	7.95E-05	1.83E-05	4.38E-05	4.95E-05	7.41E-07	1.12E-04
RH105	1.31E-17	4.04E-17	1.26E-17	2.93E-16	3.59E-16	8.05E-11	2.64E-10	7.90E-11	0.00E+00	4.23E-10
RU105	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-11	3.33E-11	9.96E-12	0.00E+00	5.34E-11
RU106	1.98E-14	6.50E-14	1.46E-14	6.60E-13	7.59E-13	1.52E-13	5.37E-13	1.15E-13	3.51E-13	1.15E-12
SR 89	7.21E-10	1.81E-09	1.52E-09	5.21E-09	9.26E-09	2.46E-09	6.32E-09	5.20E-09	5.23E-11	1.40E-08
SR 91	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.54E-13	9.11E-13	7.48E-13	0.00E+00	2.01E-12
Y 91	1.44E-10	3.62E-10	3.02E-10	1.05E-09	1.85E-09	4.65E-10	1.20E-09	9.83E-10	1.97E-11	2.66E-09
Y 92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.81E-11	4.67E-11	3.84E-11	0.00E+00	1.03E-10
Y 93	5.03E-40	1.35E-39	8.10E-40	3.69E-39	6.35E-39	3.35E-18	9.30E-18	5.43E-18	0.00E+00	1.81E-17
ZR 97	3.42E-22	8.09E-22	9.37E-22	1.18E-21	3.27E-21	3.56E-09	8.50E-09	9.78E-09	0.00E+00	2.18E-08
Others	17274.1	38081.1	61365.2	38905.2	155625.6	17273.4	38079.5	61362.6	38905.2	155620.6

Table 4.7 Actinide Mass (kg) of Startup Metal Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
U234	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U235	3.4	7.5	12.6	4.7	28.3	2.5	5.6	10.5	4.8	23.4
U236	0.2	0.5	0.5	1.0	2.3	0.4	0.8	1.0	1.1	3.3
U237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
U238	2147.5	4597.8	7268.9	4379.7	18393.9	2063.3	4429.5	7092.8	4379.7	17965.3
U239	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.4E-03	1.1E-02	1.1E-02	0.0E+00	2.7E-02
Np237	0.3	0.5	0.7	1.4	2.8	0.5	1.0	1.3	1.4	4.2
Np238	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Np239	0.0	0.0	0.0	0.0	0.0	0.8	1.5	1.6	0.0	3.9
Pu238	0.1	0.2	0.3	0.6	1.2	0.2	0.4	0.5	0.6	1.6
Pu239	449.9	1107.7	2030.0	948.8	4536.5	399.6	969.9	1830.3	948.8	4148.6
Pu240	52.2	124.1	195.5	195.1	567.0	71.0	165.3	248.1	195.1	679.6
Pu241	3.8	8.8	12.7	17.3	42.6	6.1	13.7	17.9	16.6	54.3
Pu242	0.3	0.6	0.8	1.7	3.4	0.6	1.2	1.4	1.7	4.8
Pu243	4.5E-19	7.0E-19	1.9E-19	1.3E-17	1.4E-17	3.1E-05	6.4E-05	4.8E-05	1.3E-17	1.4E-04
Am241	1.4E-01	3.3E-01	5.1E-01	1.2E+00	2.2E+00	2.9E-01	6.8E-01	1.0E+00	1.9E+00	4.0E+00
Am242m	3.1E-03	6.8E-03	7.9E-03	3.5E-02	5.3E-02	9.3E-03	2.1E-02	2.3E-02	3.5E-02	8.8E-02
Am242	3.7E-08	8.2E-08	9.4E-08	4.2E-07	6.4E-07	1.6E-04	3.5E-04	3.4E-04	4.2E-07	8.6E-04
Am243	1.1E-02	2.4E-02	2.4E-02	1.0E-01	1.6E-01	3.2E-02	6.7E-02	6.1E-02	1.0E-01	2.6E-01
Am244	1.3E-27	2.6E-27	1.7E-27	1.1E-26	1.6E-26	1.2E-05	2.2E-05	1.3E-05	0.0E+00	4.7E-05
Cm242	6.3E-03	1.4E-02	1.4E-02	6.1E-02	9.5E-02	2.0E-02	4.4E-02	4.4E-02	1.5E-02	1.2E-01
Cm243	1.5E-04	3.0E-04	2.3E-04	1.9E-03	2.6E-03	5.9E-04	1.2E-03	8.6E-04	1.9E-03	4.5E-03
Cm244	1.2E-03	2.4E-03	1.8E-03	1.4E-02	2.0E-02	4.6E-03	9.0E-03	6.0E-03	1.4E-02	3.3E-02
Cm245	6.3E-05	1.2E-04	6.1E-05	9.5E-04	1.2E-03	3.2E-04	5.9E-04	2.9E-04	9.5E-04	2.1E-03
Total	2657.9	5848.3	9522.6	5551.7	23580.5	2545.2	5590.0	9206.8	5551.7	22893.7
TRU	506.8	1242.5	2240.5	1166.3	5156.0	478.9	1154.0	2102.4	1166.2	4901.5

Table 4.8 Fission Product Mass (kg) of Startup Metal Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
Total	112.0	256.7	313.9	682.6	1365.1	224.0	513.3	627.8	682.6	2047.8
XE135	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.51E-03	1.72E-02	2.11E-02	0.00E+00	4.58E-02
I134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.94E-04	1.58E-03	1.95E-03	0.00E+00	4.23E-03
RU103	2.18E-01	5.00E-01	6.10E-01	6.84E-01	2.01E+00	5.63E-01	1.29E+00	1.57E+00	1.85E-03	3.42E+00
XE133	1.48E-03	3.38E-03	4.15E-03	4.54E-03	1.36E-02	9.57E-02	2.18E-01	2.68E-01	2.61E-22	5.82E-01
I133	4.01E-13	9.16E-13	1.13E-12	1.22E-12	3.67E-12	1.55E-02	3.54E-02	4.36E-02	0.00E+00	9.44E-02
TC103	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.93E-06	1.81E-05	2.23E-05	0.00E+00	4.84E-05
TC102	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.20E-07	1.87E-06	2.31E-06	0.00E+00	5.00E-06
MO102	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.03E-04	2.36E-04	2.90E-04	0.00E+00	6.29E-04
I135	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.81E-03	1.10E-02	1.35E-02	0.00E+00	2.93E-02
MO103	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.29E-06	2.12E-05	2.62E-05	0.00E+00	5.67E-05
TC104	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.67E-04	3.82E-04	4.70E-04	0.00E+00	1.02E-03
TC101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.32E-04	3.01E-04	3.68E-04	0.00E+00	8.01E-04
MO101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.36E-04	3.09E-04	3.79E-04	0.00E+00	8.24E-04
CS138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.82E-04	8.73E-04	1.07E-03	0.00E+00	2.33E-03
ZR 95	2.83E-01	6.48E-01	7.94E-01	8.72E-01	2.60E+00	5.90E-01	1.35E+00	1.65E+00	2.31E-02	3.62E+00
SR 90	9.24E-01	2.11E+00	2.58E+00	5.52E+00	1.11E+01	1.84E+00	4.19E+00	5.12E+00	5.40E+00	1.66E+01
Y 90	2.32E-04	5.30E-04	6.47E-04	1.38E-03	2.79E-03	5.08E-04	1.16E-03	1.37E-03	1.35E-03	4.39E-03
CS137	3.95E+00	9.07E+00	1.11E+01	2.37E+01	4.79E+01	7.86E+00	1.80E+01	2.21E+01	2.32E+01	7.12E+01
BA139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.26E-04	2.11E-03	2.60E-03	0.00E+00	5.64E-03
BA140	2.51E-02	5.73E-02	7.05E-02	7.65E-02	2.29E-01	1.91E-01	4.37E-01	5.38E-01	9.84E-10	1.17E+00
CE141	1.81E-01	4.15E-01	5.10E-01	5.54E-01	1.66E+00	5.13E-01	1.18E+00	1.44E+00	4.36E-04	3.13E+00
CE143	3.18E-09	7.26E-09	8.92E-09	9.74E-09	2.91E-08	1.76E-02	4.01E-02	4.92E-02	0.00E+00	1.07E-01
CE144	1.29E+00	2.95E+00	3.61E+00	5.16E+00	1.30E+01	2.30E+00	5.26E+00	6.43E+00	2.28E+00	1.63E+01
CS134	1.47E-01	3.20E-01	2.67E-01	1.24E+00	1.98E+00	4.03E-01	8.88E-01	7.40E-01	9.13E-01	2.94E+00
CS136	1.02E-03	2.30E-03	2.51E-03	4.04E-03	9.87E-03	8.57E-03	1.93E-02	2.03E-02	8.01E-11	4.82E-02

Table 4.8 Fission Product Mass (kg) of Startup Metal Fuel Core (continued)

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
I131	4.31E-03	9.86E-03	1.21E-02	1.32E-02	3.95E-02	8.33E-02	1.90E-01	2.34E-01	3.70E-15	5.08E-01
I132	1.52E-06	3.49E-06	4.29E-06	4.65E-06	1.40E-05	1.34E-03	3.07E-03	3.77E-03	0.00E+00	8.19E-03
KR 85	5.32E-02	1.22E-01	1.48E-01	3.13E-01	6.35E-01	1.05E-01	2.41E-01	2.92E-01	2.95E-01	9.33E-01
KR 85M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.97E-04	4.50E-04	5.54E-04	0.00E+00	1.20E-03
KR 87	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.35E-05	2.13E-04	2.61E-04	0.00E+00	5.67E-04
KR 88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.93E-04	6.67E-04	8.19E-04	0.00E+00	1.78E-03
LA140	3.78E-03	8.64E-03	1.06E-02	1.15E-02	3.46E-02	2.54E-02	5.79E-02	7.10E-02	1.48E-10	1.54E-01
LA141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.55E-03	5.83E-03	7.18E-03	0.00E+00	1.56E-02
LA142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.91E-04	2.03E-03	2.50E-03	0.00E+00	5.43E-03
MO 99	1.13E-05	2.58E-05	3.17E-05	3.50E-05	1.04E-04	3.29E-02	7.50E-02	9.17E-02	0.00E+00	2.00E-01
NB 95	1.97E-01	4.52E-01	5.54E-01	6.13E-01	1.82E+00	3.19E-01	7.30E-01	8.95E-01	2.75E-02	1.97E+00
ND147	7.16E-03	1.63E-02	1.99E-02	2.24E-02	6.58E-02	7.13E-02	1.62E-01	1.97E-01	1.68E-11	4.31E-01
PR143	2.76E-02	6.31E-02	7.76E-02	8.47E-02	2.53E-01	1.73E-01	3.95E-01	4.85E-01	3.08E-09	1.05E+00
RB 86	1.19E-04	2.61E-04	2.19E-04	6.70E-04	1.27E-03	7.69E-04	1.70E-03	1.40E-03	2.61E-09	3.87E-03
RH105	8.94E-09	2.04E-08	2.50E-08	2.79E-08	8.23E-08	1.59E-02	3.63E-02	4.42E-02	0.00E+00	9.65E-02
RU105	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.01E-03	4.59E-03	5.57E-03	0.00E+00	1.22E-02
RU106	1.27E+00	2.92E+00	3.58E+00	5.46E+00	1.32E+01	2.29E+00	5.26E+00	6.45E+00	2.91E+00	1.69E+01
SB127	1.69E-05	3.85E-05	4.72E-05	5.15E-05	1.54E-04	5.55E-03	1.26E-02	1.55E-02	3.13E-31	3.37E-02
SB129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.50E-04	1.48E-03	1.82E-03	0.00E+00	3.96E-03
SR 89	7.69E-02	1.75E-01	2.15E-01	2.34E-01	7.01E-01	1.74E-01	3.97E-01	4.86E-01	2.35E-03	1.06E+00
SR 91	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E-03	4.29E-03	5.27E-03	0.00E+00	1.15E-02
SR 92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.44E-04	1.47E-03	1.81E-03	0.00E+00	3.92E-03
TC 99M	9.95E-07	2.27E-06	2.78E-06	3.08E-06	9.12E-06	2.63E-03	5.99E-03	7.32E-03	0.00E+00	1.59E-02

Table 4.8 Fission Product Mass (kg) of Startup Metal Fuel Core (continued)

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
TE127	4.17E-05	9.54E-05	1.17E-04	1.34E-04	3.88E-04	5.55E-04	1.27E-03	1.55E-03	1.53E-05	3.39E-03
TE127M	1.15E-02	2.62E-02	3.21E-02	3.69E-02	1.07E-01	2.04E-02	4.66E-02	5.72E-02	4.38E-03	1.29E-01
TE129	6.19E-06	1.42E-05	1.74E-05	1.88E-05	5.66E-05	1.75E-04	3.98E-04	4.88E-04	1.87E-08	1.06E-03
TE129M	6.61E-03	1.51E-02	1.86E-02	2.01E-02	6.04E-02	1.83E-02	4.19E-02	5.15E-02	2.00E-05	1.12E-01
TE131M	8.02E-11	1.84E-10	2.27E-10	2.44E-10	7.34E-10	2.00E-03	4.59E-03	5.67E-03	0.00E+00	1.23E-02
TE132	5.03E-05	1.15E-04	1.42E-04	1.53E-04	4.60E-04	4.46E-02	1.02E-01	1.25E-01	0.00E+00	2.72E-01
Y 91	1.31E-01	3.00E-01	3.67E-01	4.03E-01	1.20E+00	2.80E-01	6.39E-01	7.82E-01	7.58E-03	1.71E+00
Y 92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.52E-04	1.94E-03	2.39E-03	0.00E+00	5.18E-03
Y 93	7.21E-25	1.64E-24	2.02E-24	2.19E-24	6.58E-24	3.08E-03	7.02E-03	8.64E-03	0.00E+00	1.87E-02
ZR 97	7.16E-16	1.63E-15	2.01E-15	2.19E-15	6.55E-15	7.20E-03	1.64E-02	2.02E-02	0.00E+00	4.38E-02
Others	1.03E+02	2.36E+02	2.89E+02	6.38E+02	1.27E+03	2.06E+02	4.72E+02	5.77E+02	6.48E+02	1.90E+03

Table 4.9 Activation Product Mass (kg) of Startup Metal Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
Total	17612.6	38819.5	62542.6	3.97E+04	158629.9	17611.6	38817.5	62542.6	3.97E+04	158627.0
RU103	8.45E-06	1.59E-05	7.90E-06	7.70E-05	1.09E-04	4.80E-05	9.26E-05	4.49E-05	2.08E-07	1.86E-04
TC101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.56E-06	1.17E-05	1.26E-05	0.00E+00	2.99E-05
MO101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.73E-06	1.21E-05	1.30E-05	0.00E+00	3.08E-05
ZR 95	1.63E-02	3.42E-02	3.70E-02	5.06E-02	1.38E-01	3.56E-02	7.51E-02	8.05E-02	1.34E-03	1.93E-01
SR 90	2.14E-07	4.21E-07	3.10E-07	1.78E-06	2.72E-06	6.15E-07	1.23E-06	8.87E-07	1.74E-06	4.47E-06
Y 90	1.01E-08	2.11E-08	2.28E-08	3.13E-08	8.53E-08	3.84E-05	8.10E-05	8.66E-05	4.37E-10	2.06E-04
MO 99	1.73E-06	3.62E-06	3.91E-06	5.32E-06	1.46E-05	5.23E-03	1.10E-02	1.18E-02	0.00E+00	2.80E-02
NB 95	1.13E-02	2.37E-02	2.57E-02	3.53E-02	9.60E-02	1.90E-02	4.01E-02	4.31E-02	1.60E-03	1.04E-01
RH105	2.70E-17	4.58E-17	1.02E-17	3.76E-16	4.59E-16	1.71E-10	3.05E-10	6.44E-11	0.00E+00	5.40E-10
RU105	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.16E-11	3.85E-11	8.12E-12	0.00E+00	6.82E-11
RU106	4.69E-14	7.54E-14	1.13E-14	9.11E-13	1.04E-12	3.77E-13	6.39E-13	8.96E-14	4.85E-13	1.59E-12
SR 89	8.23E-06	1.72E-05	1.86E-05	2.55E-05	6.95E-05	1.96E-05	4.13E-05	4.41E-05	2.56E-07	1.05E-04
SR 91	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.03E-08	6.39E-08	6.83E-08	0.00E+00	1.62E-07
Y 91	2.62E-05	5.49E-05	5.92E-05	8.16E-05	2.22E-04	5.91E-05	1.25E-04	1.33E-04	1.54E-06	3.18E-04
Y 92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-07	2.73E-07	2.91E-07	0.00E+00	6.93E-07
Y 93	2.54E-32	5.31E-32	5.74E-32	7.76E-32	2.13E-31	1.13E-10	2.39E-10	2.56E-10	0.00E+00	6.07E-10
ZR 97	1.28E-17	2.68E-17	2.90E-17	3.92E-17	1.08E-16	1.34E-04	2.83E-04	3.03E-04	0.00E+00	7.20E-04
Others	17612.5	38819.5	62542.5	39655.2	158629.7	17611.6	38817.4	62542.4	39655.3	158626.6

Table 4.10 Actinide Mass (kg) of Startup Oxide Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
U234	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U235	2.4	5.2	8.7	3.1	19.5	1.7	3.8	7.1	3.1	15.7
U236	0.2	0.4	0.4	0.9	1.8	0.3	0.7	0.8	0.9	2.7
U237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U238	1548.4	3267.6	5101.5	3067.1	12984.6	1480.0	3129.9	4960.2	3067.1	12637.2
U239	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.4E-03	8.9E-03	9.0E-03	0.0E+00	2.2E-02
Np237	0.2	0.4	0.5	1.0	2.1	0.3	0.7	0.9	1.0	3.0
Np238	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Np239	0.0	0.0	0.0	0.0	0.0	0.6	1.3	1.3	0.0	3.2
Pu238	0.1	0.2	0.3	0.6	1.2	0.2	0.4	0.5	0.6	1.7
Pu239	445.3	1100.0	2041.7	869.8	4456.8	376.0	917.9	1783.5	869.8	3947.1
Pu240	58.3	138.7	215.2	223.9	636.2	80.8	189.4	280.7	223.9	774.9
Pu241	4.6	10.6	14.7	22.8	52.7	7.8	17.8	22.1	21.8	69.5
Pu242	0.4	0.8	1.0	2.4	4.6	0.8	1.7	1.8	2.4	6.7
Pu243	1.2E-18	2.0E-18	5.2E-19	4.2E-17	4.5E-17	5.6E-05	1.2E-04	7.8E-05	4.2E-17	2.5E-04
Am241	1.6E-01	3.8E-01	5.7E-01	1.4E+00	2.5E+00	3.5E-01	8.1E-01	1.2E+00	2.4E+00	4.8E+00
Am242m	3.9E-03	8.9E-03	9.9E-03	4.7E-02	7.0E-02	1.2E-02	2.8E-02	3.0E-02	4.7E-02	1.2E-01
Am242	4.7E-08	1.1E-07	1.2E-07	5.7E-07	8.4E-07	2.4E-04	5.2E-04	4.8E-04	5.6E-07	1.2E-03
Am243	1.7E-02	3.5E-02	3.4E-02	1.6E-01	2.5E-01	5.1E-02	1.1E-01	8.9E-02	1.6E-01	4.1E-01
Am244	2.4E-27	4.7E-27	2.9E-27	2.3E-26	3.3E-26	2.3E-05	4.7E-05	2.4E-05	0.0E+00	9.5E-05
Cm242	8.5E-03	1.9E-02	1.9E-02	8.8E-02	1.3E-01	2.9E-02	6.3E-02	6.0E-02	2.1E-02	1.7E-01
Cm243	2.7E-04	5.5E-04	3.9E-04	3.7E-03	4.9E-03	1.1E-03	2.3E-03	1.5E-03	3.7E-03	8.6E-03
Cm244	2.1E-03	4.2E-03	2.9E-03	2.7E-02	3.6E-02	8.6E-03	1.7E-02	1.0E-02	2.6E-02	6.3E-02
Cm245	1.2E-04	2.3E-04	1.2E-04	2.1E-03	2.6E-03	6.8E-04	1.3E-03	5.8E-04	2.1E-03	4.6E-03
Total	2060.0	4524.5	7384.8	4193.2	18162.6	1949.2	4264.5	7060.8	4193.2	17467.8
TRU	509.0	1251.3	2274.1	1122.2	5156.5	467.1	1130.1	2092.2	1122.2	4811.6

Table 4.11 Fission Product Mass (kg) of Startup Oxide Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
Total	110.1	258.2	321.7	690.0	1379.9	220.1	516.4	643.4	690.0	2069.9
XE135	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.32E-03	1.71E-02	2.15E-02	0.00E+00	4.60E-02
I134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.75E-04	1.58E-03	1.98E-03	0.00E+00	4.24E-03
RU103	2.14E-01	5.03E-01	6.26E-01	6.92E-01	2.04E+00	5.53E-01	1.30E+00	1.61E+00	1.87E-03	3.46E+00
XE133	1.44E-03	3.37E-03	4.23E-03	4.55E-03	1.36E-02	9.31E-02	2.18E-01	2.73E-01	2.62E-22	5.83E-01
I133	3.90E-13	9.13E-13	1.15E-12	1.22E-12	3.68E-12	1.51E-02	3.52E-02	4.43E-02	0.00E+00	9.46E-02
TC103	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.74E-06	1.81E-05	2.28E-05	0.00E+00	4.87E-05
TC102	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.97E-07	1.86E-06	2.35E-06	0.00E+00	5.01E-06
MO102	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-04	2.35E-04	2.95E-04	0.00E+00	6.30E-04
I135	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.69E-03	1.10E-02	1.38E-02	0.00E+00	2.94E-02
MO103	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.06E-06	2.12E-05	2.67E-05	0.00E+00	5.70E-05
TC104	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.63E-04	3.82E-04	4.81E-04	0.00E+00	1.03E-03
TC101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.28E-04	2.99E-04	3.75E-04	0.00E+00	8.02E-04
MO101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.32E-04	3.08E-04	3.86E-04	0.00E+00	8.26E-04
CS138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.72E-04	8.70E-04	1.09E-03	0.00E+00	2.34E-03
ZR 95	2.76E-01	6.47E-01	8.10E-01	8.75E-01	2.61E+00	5.75E-01	1.35E+00	1.69E+00	2.31E-02	3.63E+00
SR 90	8.97E-01	2.10E+00	2.61E+00	5.51E+00	1.11E+01	1.78E+00	4.16E+00	5.19E+00	5.39E+00	1.65E+01
Y 90	2.25E-04	5.26E-04	6.55E-04	1.38E-03	2.79E-03	4.93E-04	1.15E-03	1.39E-03	1.35E-03	4.38E-03
CS137	3.90E+00	9.15E+00	1.14E+01	2.41E+01	4.85E+01	7.74E+00	1.82E+01	2.27E+01	2.36E+01	7.22E+01
BA139	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.01E-04	2.10E-03	2.65E-03	0.00E+00	5.65E-03
BA140	2.44E-02	5.71E-02	7.18E-02	7.67E-02	2.30E-01	1.86E-01	4.35E-01	5.47E-01	9.85E-10	1.17E+00
CE141	1.78E-01	4.16E-01	5.22E-01	5.58E-01	1.67E+00	5.03E-01	1.18E+00	1.48E+00	4.39E-04	3.16E+00
CE143	3.09E-09	7.22E-09	9.07E-09	9.74E-09	2.91E-08	1.71E-02	3.98E-02	5.00E-02	0.00E+00	1.07E-01
CE144	1.26E+00	2.95E+00	3.68E+00	5.19E+00	1.31E+01	2.25E+00	5.27E+00	6.57E+00	2.29E+00	1.64E+01
CS134	1.40E-01	3.20E-01	2.75E-01	1.28E+00	2.02E+00	3.93E-01	9.08E-01	7.74E-01	9.44E-01	3.02E+00
CS136	9.98E-04	2.33E-03	2.60E-03	4.18E-03	1.01E-02	8.46E-03	1.98E-02	2.12E-02	8.28E-11	4.94E-02

Table 4.11 Fission Product Mass (kg) of Startup Oxide Fuel Core (continued)

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
I131	4.20E-03	9.83E-03	1.24E-02	1.32E-02	3.96E-02	8.10E-02	1.90E-01	2.39E-01	3.70E-15	5.09E-01
I132	1.49E-06	3.47E-06	4.37E-06	4.65E-06	1.40E-05	1.31E-03	3.05E-03	3.84E-03	0.00E+00	8.20E-03
KR 85	5.17E-02	1.21E-01	1.50E-01	3.13E-01	6.36E-01	1.02E-01	2.40E-01	2.97E-01	2.95E-01	9.34E-01
KR 85M	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.90E-04	4.42E-04	5.57E-04	0.00E+00	1.19E-03
KR 87	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.94E-05	2.08E-04	2.61E-04	0.00E+00	5.59E-04
KR 88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.80E-04	6.52E-04	8.19E-04	0.00E+00	1.75E-03
LA140	3.68E-03	8.61E-03	1.08E-02	1.16E-02	3.47E-02	2.47E-02	5.77E-02	7.23E-02	1.49E-10	1.55E-01
LA141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.48E-03	5.81E-03	7.32E-03	0.00E+00	1.56E-02
LA142	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.65E-04	2.02E-03	2.55E-03	0.00E+00	5.44E-03
MO 99	1.10E-05	2.57E-05	3.22E-05	3.51E-05	1.04E-04	3.20E-02	7.47E-02	9.33E-02	0.00E+00	2.00E-01
NB 95	1.93E-01	4.52E-01	5.66E-01	6.15E-01	1.83E+00	3.12E-01	7.30E-01	9.13E-01	2.76E-02	1.98E+00
ND147	6.94E-03	1.62E-02	2.02E-02	2.24E-02	6.58E-02	6.91E-02	1.61E-01	2.00E-01	1.68E-11	4.31E-01
PR143	2.68E-02	6.28E-02	7.89E-02	8.47E-02	2.53E-01	1.68E-01	3.92E-01	4.93E-01	3.08E-09	1.05E+00
RB 86	1.13E-04	2.60E-04	2.25E-04	6.99E-04	1.30E-03	7.51E-04	1.74E-03	1.46E-03	2.72E-09	3.95E-03
RH105	8.74E-09	2.05E-08	2.56E-08	2.82E-08	8.30E-08	1.56E-02	3.64E-02	4.53E-02	0.00E+00	9.73E-02
RU105	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.97E-03	4.60E-03	5.71E-03	0.00E+00	1.23E-02
RU106	1.26E+00	2.97E+00	3.71E+00	5.58E+00	1.35E+01	2.27E+00	5.35E+00	6.68E+00	2.97E+00	1.73E+01
SB127	1.62E-05	3.78E-05	4.75E-05	5.09E-05	1.52E-04	5.33E-03	1.24E-02	1.56E-02	3.09E-31	3.34E-02
SB129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.29E-04	1.47E-03	1.85E-03	0.00E+00	3.95E-03
SR 89	7.41E-02	1.73E-01	2.16E-01	2.32E-01	6.95E-01	1.68E-01	3.92E-01	4.90E-01	2.33E-03	1.05E+00
SR 91	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.81E-03	4.21E-03	5.29E-03	0.00E+00	1.13E-02
SR 92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.19E-04	1.45E-03	1.82E-03	0.00E+00	3.88E-03
TC 99M	9.67E-07	2.26E-06	2.83E-06	3.08E-06	9.14E-06	2.55E-03	5.97E-03	7.45E-03	0.00E+00	1.60E-02

Table 4.11 Fission Product Mass (kg) of Startup Oxide Fuel Core (continued)

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
TE127	4.05E-05	9.47E-05	1.18E-04	1.34E-04	3.87E-04	5.34E-04	1.25E-03	1.56E-03	1.53E-05	3.36E-03
TE127M	1.11E-02	2.60E-02	3.25E-02	3.68E-02	1.06E-01	1.98E-02	4.63E-02	5.79E-02	4.37E-03	1.28E-01
TE129	6.04E-06	1.42E-05	1.77E-05	1.89E-05	5.68E-05	1.69E-04	3.95E-04	4.95E-04	1.88E-08	1.06E-03
TE129M	6.45E-03	1.51E-02	1.90E-02	2.02E-02	6.07E-02	1.79E-02	4.18E-02	5.25E-02	2.00E-05	1.12E-01
TE131M	7.84E-11	1.84E-10	2.32E-10	2.44E-10	7.39E-10	1.96E-03	4.58E-03	5.80E-03	0.00E+00	1.23E-02
TE132	4.90E-05	1.14E-04	1.44E-04	1.54E-04	4.61E-04	4.34E-02	1.01E-01	1.28E-01	0.00E+00	2.73E-01
Y 91	1.27E-01	2.97E-01	3.71E-01	4.00E-01	1.19E+00	2.70E-01	6.32E-01	7.89E-01	7.53E-03	1.70E+00
Y 92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.19E-04	1.91E-03	2.40E-03	0.00E+00	5.13E-03
Y 93	6.96E-25	1.63E-24	2.05E-24	2.17E-24	6.54E-24	2.97E-03	6.93E-03	8.72E-03	0.00E+00	1.86E-02
ZR 97	6.95E-16	1.62E-15	2.04E-15	2.19E-15	6.55E-15	6.98E-03	1.63E-02	2.05E-02	0.00E+00	4.38E-02
Others	1.01E+02	2.38E+02	2.97E+02	6.44E+02	1.28E+03	2.02E+02	4.75E+02	5.92E+02	6.54E+02	1.92E+03

Table 4.12 Activation Product Mass (kg) of Startup Oxide Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
Total	17240.5	37999.5	61221.5	38820.5	155282.1	17240.5	37999.5	61224.1	38820.5	155284.7
RU103	7.54E-06	1.53E-05	7.90E-06	8.02E-05	1.11E-04	4.58E-05	9.55E-05	4.70E-05	2.16E-07	1.89E-04
TC101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.50E-06	1.19E-05	1.28E-05	0.00E+00	3.03E-05
MO101	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.67E-06	1.23E-05	1.32E-05	0.00E+00	3.12E-05
ZR 95	7.15E-06	1.53E-05	1.67E-05	2.45E-05	6.37E-05	1.61E-05	3.49E-05	3.71E-05	6.48E-07	8.88E-05
SR 90	1.41E-10	2.92E-10	2.15E-10	1.43E-09	2.08E-09	4.55E-10	9.55E-10	6.75E-10	1.40E-09	3.49E-09
Y 90	2.02E-13	4.21E-13	3.13E-13	1.37E-12	2.31E-12	9.35E-10	1.99E-09	1.43E-09	3.52E-13	4.35E-09
MO 99	1.67E-06	3.59E-06	3.92E-06	5.57E-06	1.48E-05	5.17E-03	1.12E-02	1.20E-02	0.00E+00	2.84E-02
NB 95	9.15E-06	1.96E-05	2.12E-05	3.19E-05	8.18E-05	2.12E-05	4.57E-05	4.82E-05	7.92E-07	1.16E-04
RH105	2.26E-17	4.36E-17	1.03E-17	4.01E-16	4.78E-16	1.62E-10	3.29E-10	7.07E-11	0.00E+00	5.62E-10
RU105	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.05E-11	4.16E-11	8.91E-12	0.00E+00	7.10E-11
RU106	3.76E-14	7.05E-14	1.13E-14	9.62E-13	1.08E-12	3.50E-13	6.95E-13	9.95E-14	5.12E-13	1.66E-12
SR 89	8.88E-10	1.85E-09	1.39E-09	5.77E-09	9.90E-09	3.21E-09	6.81E-09	4.93E-09	5.79E-11	1.50E-08
SR 91	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.64E-13	9.86E-13	7.10E-13	0.00E+00	2.16E-12
Y 91	1.77E-10	3.70E-10	2.77E-10	1.16E-09	1.98E-09	6.07E-10	1.29E-09	9.30E-10	2.18E-11	2.85E-09
Y 92	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.38E-11	5.05E-11	3.64E-11	0.00E+00	1.11E-10
Y 93	6.88E-40	1.39E-39	7.09E-40	4.37E-39	7.16E-39	5.00E-18	1.04E-17	4.98E-18	0.00E+00	2.04E-17
ZR 97	3.83E-22	8.22E-22	9.00E-22	1.26E-21	3.37E-21	4.09E-09	8.87E-09	9.54E-09	0.00E+00	2.25E-08
Others	17240.5	37999.5	61221.5	38820.5	155282.1	17240.5	37999.5	61224.1	38820.5	155284.6

For the startup core, the heavy metal mass of the metal core increases to 23.6 MT from 17.8 MT of the recycled core, since the Zr fraction is decreased from 20% to 10% within the same geometry. The heavy metal mass of the oxide core is practically the same to the recycled core; a minor variation is due to the TRU feed change. Since weapons-grade plutonium is used for the startup cores, the TRU masses in the startup cores are reduced to 5.2 MT for both metal and oxide fuel cores. The fission product inventory is comparable to the recycled cores because the same power was generated.

4.2. Isotopic Radioactivity

The calculated isotopic radioactivity at BOEC and EOEC are summarized in Tables 4.13 to 4.24 for heavy metal nuclides, leading radioactive fission products, and activation products. The radioactivity inventory at BOEC represents the radioactivity one month after reactor shutdown, and thus the contribution of highly radioactive isotopes is negligible since most of them disappear during the refueling time due to their short half-lives. However, the contribution of short-lived isotopes to the total radioactivity is dominant during the reactor operation. As a result, compared to the BOEC radioactivity, the total EOEC radioactivity is about 13 times higher for the recycled cores and about 16 times higher for the startup cores. The total radioactivity at BOEC is about 8.2×10^{8} curies for the recycled cores and about 6.9×10^{8} curies for the startup cores, and the total radioactivity at EOEC is about 1.1×10^{10} curies for all four cases. The radioactivity inventory of the spent fuel storage shows that after one-year cooling, the fission product radioactivity is reduced by about 79% but the heavy metal radioactivity is reduced by only about 38% for the recycled cores and about 13% for the startup cores.

Fission products are the dominant contributor to the total radioactivity. The contribution of fission products is more than 80% at EOEC for all four cases. Since the same amount of energy is generated, the radioactivity of fission products is comparable for all four cases; it is about 6.2×10^{8} curies at BOEC and about 9.1×10^{8} curies at EOEC. The heavy metal radioactivity of the recycled cores is about 1.4×10^{8} curies at BOEC and about 1.4×10^{9} curies at EOEC. The leading contributors are Pu-241, Cm-242, Cm-244, and Pu-238 at BOEC and U-239, Np-239, Pu-243, and Am-242 at EOEC. The short-lived isotopes (U-239, Np-239, Pu-243, and Am242) are dominant contributors during reactor operation, but they decay out quickly during the refueling time. In the startup cores fueled with weapons-grade plutonium, the mass inventory of Pu-241, Cm-242, and Pu-238 is very small and thus the heavy metal radioactivity at BOEC is more than 20 times smaller than that of recycled cores. However, the EOEC radioactivity is somewhat larger than that of recycled cores because of a higher contribution of U-239 and Np-239 from the higher U-238 inventory.

Table 4.13 Actinide Radioactivity (Curies) of Recycled Metal Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
U234	1.341E+00	3.318E+00	6.150E+00	9.832E+00	2.064E+01	2.426E+00	5.977E+00	1.131E+01	1.328E+01	3.299E+01
U235	4.171E-03	8.364E-03	1.308E-02	5.299E-03	3.092E-02	3.161E-03	6.368E-03	1.088E-02	5.333E-03	2.574E-02
U236	9.641E-03	1.967E-02	2.474E-02	4.742E-02	1.015E-01	1.762E-02	3.609E-02	4.654E-02	5.167E-02	1.519E-01
U237	1.288E+04	2.849E+04	3.257E+04	4.263E+04	1.166E+05	4.379E+05	9.756E+05	1.103E+06	3.121E+02	2.517E+06
U238	3.998E-01	7.980E-01	1.174E+00	7.392E-01	3.111E+00	3.849E-01	7.679E-01	1.144E+00	7.392E-01	3.036E+00
U239	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.526E+07	1.895E+08	1.902E+08	0.000E+00	4.750E+08
Np237	8.670E+00	2.166E+01	4.086E+01	1.615E+01	8.734E+01	6.942E+00	1.735E+01	3.506E+01	1.623E+01	7.558E+01
Np238	2.737E+02	6.670E+02	9.800E+02	8.462E+02	2.767E+03	4.980E+06	1.214E+07	1.653E+07	3.008E+02	3.365E+07
Np239	1.278E+04	2.706E+04	3.443E+04	3.874E+04	1.130E+05	9.518E+07	1.894E+08	1.901E+08	1.406E+04	4.746E+08
Pu238	5.270E+05	1.304E+06	2.358E+06	1.289E+06	5.478E+06	4.985E+05	1.226E+06	2.263E+06	1.347E+06	5.334E+06
Pu239	1.704E+04	4.142E+04	7.563E+04	3.457E+04	1.687E+05	1.517E+04	3.585E+04	6.716E+04	3.457E+04	1.527E+05
Pu240	6.551E+04	1.625E+05	2.937E+05	1.569E+05	6.786E+05	6.213E+04	1.532E+05	2.816E+05	1.573E+05	6.543E+05
Pu241	5.769E+06	1.427E+07	2.561E+07	1.330E+07	5.894E+07	5.423E+06	1.330E+07	2.409E+07	1.272E+07	5.554E+07
Pu242	3.268E+02	8.123E+02	1.460E+03	8.063E+02	3.405E+03	3.149E+02	7.804E+02	1.417E+03	8.063E+02	3.318E+03
Pu243	3.615E-04	8.358E-04	7.382E-04	3.474E-03	5.409E-03	1.077E+07	2.623E+07	3.307E+07	3.474E-03	7.007E+07
Am241	1.157E+05	2.888E+05	5.458E+05	2.474E+05	1.198E+06	9.845E+04	2.457E+05	4.964E+05	2.662E+05	1.107E+06
Am242m	2.394E+04	5.941E+04	1.066E+05	6.040E+04	2.504E+05	2.347E+04	5.806E+04	1.072E+05	6.015E+04	2.489E+05
Am242	1.608E+04	3.983E+04	7.171E+04	6.010E+04	1.877E+05	1.140E+07	2.804E+07	3.838E+07	5.985E+04	7.787E+07
Am243	5.507E+03	1.369E+04	2.457E+04	1.406E+04	5.783E+04	5.399E+03	1.339E+04	2.423E+04	1.406E+04	5.707E+04
Am244	2.416E-15	5.823E-15	7.149E-15	8.565E-15	2.395E-14	1.079E+07	2.621E+07	3.202E+07	0.000E+00	6.901E+07
Cm242	5.210E+06	1.269E+07	1.703E+07	1.759E+07	5.252E+07	8.466E+06	2.075E+07	2.800E+07	4.273E+06	6.149E+07
Cm243	1.059E+04	2.581E+04	4.328E+04	2.781E+04	1.075E+05	1.120E+04	2.687E+04	4.197E+04	2.719E+04	1.072E+05
Cm244	1.601E+06	3.956E+06	6.903E+06	4.304E+06	1.676E+07	1.661E+06	4.076E+06	6.989E+06	4.156E+06	1.688E+07
Cm245	9.476E+02	2.339E+03	4.140E+03	2.487E+03	9.913E+03	9.610E+02	2.350E+03	4.117E+03	2.487E+03	9.915E+03
Total	1.339E+07	3.291E+07	5.314E+07	3.717E+07	1.366E+08	2.451E+08	5.125E+08	5.638E+08	2.314E+07	1.345E+09
TRU	1.338E+07	3.288E+07	5.310E+07	3.713E+07	1.365E+08	1.494E+08	3.220E+08	3.725E+08	2.314E+07	8.671E+08

Table 4.14 Fission Product Radioactivity (Curies) of Recycled Metal Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
Total	5.931E+07	1.471E+08	1.889E+08	2.261E+08	6.214E+08	1.360E+09	3.355E+09	4.309E+09	4.849E+07	9.072E+09
XE135	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.741E+07	4.302E+07	5.550E+07	0.000E+00	1.159E+08
I134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.720E+07	4.245E+07	5.479E+07	0.000E+00	1.144E+08
RU103	6.399E+06	1.589E+07	2.038E+07	2.199E+07	6.466E+07	1.649E+07	4.096E+07	5.232E+07	5.933E+04	1.098E+08
XE133	2.510E+05	6.203E+05	8.003E+05	8.421E+05	2.514E+06	1.623E+07	4.010E+07	5.162E+07	4.847E-14	1.079E+08
I133	4.123E-04	1.018E-03	1.316E-03	1.373E-03	4.120E-03	1.593E+07	3.932E+07	5.081E+07	0.000E+00	1.061E+08
TC103	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.580E+07	3.904E+07	5.050E+07	0.000E+00	1.053E+08
TC102	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.560E+07	3.850E+07	4.976E+07	0.000E+00	1.039E+08
MO102	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.556E+07	3.843E+07	4.967E+07	0.000E+00	1.037E+08
I135	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.550E+07	3.827E+07	4.944E+07	0.000E+00	1.032E+08
MO103	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.546E+07	3.820E+07	4.941E+07	0.000E+00	1.031E+08
TC104	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.548E+07	3.825E+07	4.945E+07	0.000E+00	1.032E+08
TC101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.558E+07	3.849E+07	4.950E+07	0.000E+00	1.036E+08
MO101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.557E+07	3.847E+07	4.947E+07	0.000E+00	1.035E+08
CS138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.475E+07	3.643E+07	4.705E+07	0.000E+00	9.823E+07
ZR 95	5.352E+06	1.326E+07	1.709E+07	1.806E+07	5.376E+07	1.116E+07	2.765E+07	3.560E+07	4.781E+05	7.488E+07
SR 90	1.081E+05	2.675E+05	3.432E+05	7.066E+05	1.425E+06	2.147E+05	5.314E+05	6.821E+05	6.914E+05	2.120E+06
Y 90	1.082E+05	2.677E+05	3.434E+05	7.071E+05	1.426E+06	2.355E+05	5.851E+05	7.303E+05	6.916E+05	2.242E+06
CS137	3.154E+05	7.839E+05	1.008E+06	2.074E+06	4.182E+06	6.270E+05	1.558E+06	2.005E+06	2.031E+06	6.221E+06
BA139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.390E+07	3.432E+07	4.429E+07	0.000E+00	9.252E+07
BA140	1.680E+06	4.148E+06	5.359E+06	5.594E+06	1.678E+07	1.282E+07	3.164E+07	4.085E+07	7.193E-02	8.530E+07
CE141	4.647E+06	1.152E+07	1.485E+07	1.554E+07	4.656E+07	1.316E+07	3.260E+07	4.202E+07	1.222E+04	8.779E+07
CE143	1.913E+00	4.725E+00	6.095E+00	6.407E+00	1.914E+01	1.057E+07	2.609E+07	3.361E+07	0.000E+00	7.027E+07
CE144	3.767E+06	9.341E+06	1.201E+07	1.651E+07	4.163E+07	6.717E+06	1.666E+07	2.141E+07	7.290E+06	5.208E+07
CS134	1.629E+05	4.165E+05	3.836E+05	1.630E+06	2.593E+06	4.481E+05	1.156E+06	1.062E+06	1.197E+06	3.863E+06
CS136	6.206E+04	1.562E+05	1.799E+05	2.838E+05	6.820E+05	5.247E+05	1.331E+06	1.479E+06	5.626E-03	3.335E+06

Table 4.14 Fission Product Radioactivity (Curies) of Recycled Metal Fuel Core (continued)

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
I131	4.819E+05	1.191E+06	1.540E+06	1.607E+06	4.819E+06	9.318E+06	2.301E+07	2.973E+07	4.516E-07	6.206E+07
I132	1.433E+04	3.534E+04	4.571E+04	4.771E+04	1.431E+05	1.258E+07	3.105E+07	4.011E+07	0.000E+00	8.374E+07
KR 85	1.762E+04	4.368E+04	5.588E+04	1.136E+05	2.308E+05	3.491E+04	8.656E+04	1.105E+05	1.071E+05	3.390E+05
KR 85M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.380E+06	3.396E+06	4.384E+06	0.000E+00	9.160E+06
KR 87	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.296E+06	5.641E+06	7.261E+06	0.000E+00	1.520E+07
KR 88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.164E+06	7.771E+06	1.000E+07	0.000E+00	2.094E+07
LA140	1.933E+06	4.775E+06	6.165E+06	6.439E+06	1.931E+07	1.296E+07	3.200E+07	4.120E+07	8.277E-02	8.615E+07
LA141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.298E+07	3.206E+07	4.147E+07	0.000E+00	8.651E+07
LA142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.147E+07	2.832E+07	3.660E+07	0.000E+00	7.639E+07
MO 99	4.943E+03	1.221E+04	1.571E+04	1.671E+04	4.958E+04	1.435E+07	3.547E+07	4.551E+07	0.000E+00	9.533E+07
NB 95	6.797E+06	1.686E+07	2.171E+07	2.311E+07	6.848E+07	1.097E+07	2.722E+07	3.507E+07	1.038E+06	7.430E+07
ND147	5.292E+05	1.306E+06	1.674E+06	1.807E+06	5.316E+06	5.258E+06	1.299E+07	1.657E+07	1.356E-03	3.482E+07
PR143	1.686E+06	4.163E+06	5.374E+06	5.646E+06	1.687E+07	1.055E+07	2.604E+07	3.357E+07	2.051E-01	7.016E+07
RB 86	7.759E+03	1.985E+04	1.838E+04	5.150E+04	9.748E+04	4.997E+04	1.293E+05	1.178E+05	2.008E-01	2.971E+05
RH105	7.093E+00	1.755E+01	2.256E+01	2.425E+01	7.146E+01	1.261E+07	3.122E+07	3.996E+07	0.000E+00	8.379E+07
RU105	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.268E+07	3.139E+07	4.011E+07	0.000E+00	8.418E+07
RU106	4.151E+06	1.033E+07	1.332E+07	1.954E+07	4.734E+07	7.481E+06	1.862E+07	2.399E+07	1.040E+07	6.048E+07
SB127	3.986E+03	9.820E+03	1.265E+04	1.327E+04	3.972E+04	1.309E+06	3.223E+06	4.151E+06	8.064E-23	8.684E+06
SB129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.290E+06	8.115E+06	1.048E+07	0.000E+00	2.188E+07
SR 89	1.898E+06	4.686E+06	6.021E+06	6.323E+06	1.893E+07	4.302E+06	1.062E+07	1.365E+07	6.344E+04	2.863E+07
SR 91	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.868E+06	1.443E+07	1.860E+07	0.000E+00	3.890E+07
SR 92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.005E+06	1.724E+07	2.225E+07	0.000E+00	4.650E+07
TC 99M	4.763E+03	1.177E+04	1.514E+04	1.610E+04	4.776E+04	1.257E+07	3.105E+07	3.984E+07	0.000E+00	8.346E+07

Table 4.14 Fission Product Radioactivity (Curies) of Recycled Metal Fuel Core (continued)

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
TE127	9.746E+04	2.410E+05	3.104E+05	3.424E+05	9.913E+05	1.295E+06	3.191E+06	4.108E+06	3.912E+04	8.633E+06
TE127M	9.562E+04	2.365E+05	3.045E+05	3.366E+05	9.733E+05	1.702E+05	4.209E+05	5.421E+05	3.994E+04	1.173E+06
TE129	1.151E+05	2.851E+05	3.679E+05	3.839E+05	1.152E+06	3.277E+06	8.091E+06	1.040E+07	3.807E+02	2.177E+07
TE129M	1.768E+05	4.380E+05	5.652E+05	5.899E+05	1.770E+06	4.904E+05	1.214E+06	1.566E+06	5.847E+02	3.271E+06
TE131M	5.584E-02	1.382E-01	1.793E-01	1.860E-01	5.594E-01	1.398E+06	3.457E+06	4.485E+06	0.000E+00	9.340E+06
TE132	1.390E+04	3.431E+04	4.430E+04	4.630E+04	1.388E+05	1.231E+07	3.040E+07	3.927E+07	0.000E+00	8.198E+07
Y 91	2.766E+06	6.835E+06	8.779E+06	9.270E+06	2.765E+07	5.897E+06	1.457E+07	1.871E+07	1.747E+05	3.935E+07
Y 92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.084E+06	1.744E+07	2.250E+07	0.000E+00	4.703E+07
Y 93	2.096E-15	5.167E-15	6.676E-15	6.965E-15	2.090E-14	8.956E+06	2.206E+07	2.850E+07	0.000E+00	5.952E+07
ZR 97	1.221E-06	3.016E-06	3.891E-06	4.091E-06	1.222E-05	1.228E+07	3.031E+07	3.906E+07	0.000E+00	8.165E+07
Others	1.566E+07	3.892E+07	4.982E+07	6.645E+07	1.709E+08	8.391E+08	2.069E+09	2.652E+09	2.417E+07	5.584E+09

Table 4.15 Activation Product Radioactivity (Curies) of Recycled Metal Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
Total	6.731E+06	1.522E+07	1.746E+07	2.736E+07	6.678E+07	4.093E+07	9.373E+07	1.058E+08	1.004E+07	2.505E+08
RU103	2.322E+02	5.550E+02	3.199E+02	2.634E+03	3.741E+03	1.311E+03	3.226E+03	1.814E+03	7.104E+00	6.359E+03
TC101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.897E+05	1.581E+06	1.785E+06	0.000E+00	4.056E+06
MO101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.897E+05	1.581E+06	1.785E+06	0.000E+00	4.056E+06
ZR 95	5.757E+05	1.306E+06	1.487E+06	1.945E+06	5.314E+06	1.252E+06	2.868E+06	3.235E+06	5.148E+04	7.407E+06
SR 90	4.543E-02	1.051E-01	8.523E-02	4.426E-01	6.784E-01	1.301E-01	3.056E-01	2.440E-01	4.331E-01	1.113E+00
Y 90	9.000E+00	2.045E+01	2.320E+01	3.043E+01	8.307E+01	3.416E+04	7.836E+04	8.814E+04	4.331E-01	2.007E+05
MO 99	7.854E+02	1.784E+03	2.025E+03	2.639E+03	7.233E+03	2.369E+06	5.437E+06	6.105E+06	0.000E+00	1.391E+07
NB 95	7.261E+05	1.646E+06	1.877E+06	2.469E+06	6.718E+06	1.217E+06	2.784E+06	3.148E+06	1.118E+05	7.261E+06
RH105	1.729E-08	4.395E-08	1.255E-08	3.335E-07	4.073E-07	1.087E-01	2.914E-01	7.915E-02	0.000E+00	4.792E-01
RU105	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.093E-01	2.933E-01	7.949E-02	0.000E+00	4.821E-01
RU106	1.129E-07	2.945E-07	5.934E-08	3.170E-06	3.637E-06	8.936E-07	2.484E-06	4.708E-07	1.687E-06	5.535E-06
SR 89	3.919E+02	8.898E+02	1.010E+03	1.326E+03	3.617E+03	9.307E+02	2.134E+03	2.395E+03	1.330E+01	5.473E+03
SR 91	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.795E+02	4.117E+02	4.630E+02	0.000E+00	1.054E+03
Y 91	1.055E+03	2.394E+03	2.716E+03	3.579E+03	9.745E+03	2.370E+03	5.434E+03	6.097E+03	6.743E+01	1.397E+04
Y 92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.035E+03	4.668E+03	5.237E+03	0.000E+00	1.194E+04
Y 93	1.386E-22	3.148E-22	3.580E-22	4.631E-22	1.274E-21	6.171E-01	1.415E+00	1.594E+00	0.000E+00	3.627E+00
ZR 97	4.010E-08	9.109E-08	1.036E-07	1.340E-07	3.687E-07	4.192E+05	9.618E+05	1.083E+06	0.000E+00	2.464E+06
Others	5.427E+06	1.227E+07	1.409E+07	2.294E+07	5.472E+07	3.425E+07	7.842E+07	8.852E+07	9.878E+06	2.111E+08

Table 4.16 Actinide Radioactivity (Curies) of Recycled Oxide Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
U234	1.349E+00	3.325E+00	6.162E+00	9.679E+00	2.052E+01	2.445E+00	5.992E+00	1.131E+01	1.332E+01	3.307E+01
U235	4.273E-03	8.523E-03	1.337E-02	5.340E-03	3.150E-02	3.239E-03	6.431E-03	1.103E-02	5.372E-03	2.607E-02
U236	1.022E-02	2.123E-02	2.663E-02	5.049E-02	1.086E-01	1.864E-02	3.878E-02	4.993E-02	5.484E-02	1.622E-01
U237	1.348E+04	3.070E+04	3.539E+04	4.556E+04	1.251E+05	4.565E+05	1.048E+06	1.197E+06	3.316E+02	2.702E+06
U238	4.099E-01	8.187E-01	1.207E+00	7.568E-01	3.193E+00	3.944E-01	7.864E-01	1.174E+00	7.568E-01	3.111E+00
U239	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.870E+07	2.040E+08	2.079E+08	0.000E+00	5.106E+08
Np237	7.989E+00	1.984E+01	3.752E+01	1.451E+01	7.985E+01	6.362E+00	1.569E+01	3.186E+01	1.458E+01	6.849E+01
Np238	2.664E+02	6.611E+02	9.770E+02	8.254E+02	2.730E+03	4.816E+06	1.201E+07	1.656E+07	2.927E+02	3.339E+07
Np239	1.322E+04	2.869E+04	3.646E+04	4.068E+04	1.190E+05	9.861E+07	2.038E+08	2.078E+08	1.432E+04	5.102E+08
Pu238	5.301E+05	1.310E+06	2.367E+06	1.296E+06	5.503E+06	5.027E+05	1.231E+06	2.272E+06	1.356E+06	5.361E+06
Pu239	1.716E+04	4.156E+04	7.565E+04	3.501E+04	1.694E+05	1.544E+04	3.620E+04	6.733E+04	3.501E+04	1.540E+05
Pu240	6.661E+04	1.650E+05	2.978E+05	1.600E+05	6.893E+05	6.349E+04	1.560E+05	2.859E+05	1.604E+05	6.659E+05
Pu241	6.057E+06	1.497E+07	2.677E+07	1.413E+07	6.193E+07	5.753E+06	1.409E+07	2.533E+07	1.352E+07	5.869E+07
Pu242	3.320E+02	8.245E+02	1.481E+03	8.212E+02	3.458E+03	3.209E+02	7.938E+02	1.439E+03	8.212E+02	3.374E+03
Pu243	4.704E-04	1.157E-03	1.030E-03	4.760E-03	7.418E-03	1.153E+07	2.908E+07	3.683E+07	4.760E-03	7.744E+07
Am241	1.123E+05	2.786E+05	5.275E+05	2.380E+05	1.156E+06	9.578E+04	2.358E+05	4.779E+05	2.580E+05	1.067E+06
Am242m	2.336E+04	5.789E+04	1.040E+05	5.877E+04	2.441E+05	2.295E+04	5.652E+04	1.047E+05	5.855E+04	2.427E+05
Am242	1.571E+04	3.884E+04	7.006E+04	5.848E+04	1.831E+05	1.142E+07	2.874E+07	3.979E+07	5.824E+04	8.000E+07
Am243	5.604E+03	1.393E+04	2.499E+04	1.432E+04	5.884E+04	5.503E+03	1.363E+04	2.465E+04	1.432E+04	5.811E+04
Am244	2.604E-15	6.504E-15	8.034E-15	9.483E-15	2.662E-14	1.159E+07	2.919E+07	3.593E+07	0.000E+00	7.671E+07
Cm242	5.230E+06	1.307E+07	1.768E+07	1.795E+07	5.393E+07	8.472E+06	2.127E+07	2.901E+07	4.358E+06	6.311E+07
Cm243	1.222E+04	3.003E+04	5.020E+04	3.223E+04	1.247E+05	1.284E+04	3.129E+04	4.869E+04	3.152E+04	1.243E+05
Cm244	1.750E+06	4.336E+06	7.566E+06	4.715E+06	1.837E+07	1.813E+06	4.470E+06	7.663E+06	4.552E+06	1.850E+07
Cm245	1.098E+03	2.712E+03	4.796E+03	2.881E+03	1.149E+04	1.112E+03	2.727E+03	4.768E+03	2.881E+03	1.149E+04
Total	1.385E+07	3.438E+07	5.562E+07	3.878E+07	1.426E+08	2.540E+08	5.495E+08	6.114E+08	2.442E+07	1.439E+09
TRU	1.384E+07	3.435E+07	5.559E+07	3.874E+07	1.425E+08	1.549E+08	3.445E+08	4.023E+08	2.442E+07	9.261E+08

Table 4.17 Fission Product Radioactivity (Curies) of Recycled Oxide Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
Total	5.762E+07	1.472E+08	1.906E+08	2.261E+08	6.215E+08	1.326E+09	3.370E+09	4.361E+09	4.859E+07	9.105E+09
XE135	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.693E+07	4.308E+07	5.600E+07	0.000E+00	1.160E+08
I134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.678E+07	4.265E+07	5.544E+07	0.000E+00	1.149E+08
RU103	6.207E+06	1.588E+07	2.054E+07	2.194E+07	6.457E+07	1.598E+07	4.091E+07	5.273E+07	5.917E+04	1.097E+08
XE133	2.442E+05	6.211E+05	8.077E+05	8.426E+05	2.516E+06	1.578E+07	4.016E+07	5.210E+07	4.851E-14	1.080E+08
I133	4.014E-04	1.020E-03	1.329E-03	1.376E-03	4.126E-03	1.551E+07	3.941E+07	5.131E+07	0.000E+00	1.062E+08
TC103	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.537E+07	3.910E+07	5.097E+07	0.000E+00	1.054E+08
TC102	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.518E+07	3.859E+07	5.025E+07	0.000E+00	1.040E+08
MO102	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.516E+07	3.852E+07	5.015E+07	0.000E+00	1.038E+08
I135	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.510E+07	3.838E+07	4.996E+07	0.000E+00	1.034E+08
MO103	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.505E+07	3.828E+07	4.987E+07	0.000E+00	1.032E+08
TC104	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.509E+07	3.839E+07	4.999E+07	0.000E+00	1.035E+08
TC101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.514E+07	3.853E+07	4.994E+07	0.000E+00	1.036E+08
MO101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.513E+07	3.851E+07	4.992E+07	0.000E+00	1.036E+08
CS138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.436E+07	3.652E+07	4.752E+07	0.000E+00	9.840E+07
ZR 95	5.195E+06	1.325E+07	1.721E+07	1.804E+07	5.370E+07	1.083E+07	2.762E+07	3.587E+07	4.775E+05	7.480E+07
SR 90	1.048E+05	2.673E+05	3.457E+05	7.056E+05	1.423E+06	2.083E+05	5.309E+05	6.869E+05	6.902E+05	2.116E+06
Y 90	1.049E+05	2.673E+05	3.460E+05	7.061E+05	1.424E+06	2.265E+05	5.814E+05	7.341E+05	6.906E+05	2.233E+06
CS137	3.064E+05	7.845E+05	1.018E+06	2.076E+06	4.185E+06	6.093E+05	1.560E+06	2.023E+06	2.032E+06	6.225E+06
BA139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.355E+07	3.444E+07	4.478E+07	0.000E+00	9.277E+07
BA140	1.638E+06	4.162E+06	5.417E+06	5.611E+06	1.683E+07	1.249E+07	3.175E+07	4.129E+07	7.213E-02	8.553E+07
CE141	4.513E+06	1.152E+07	1.498E+07	1.553E+07	4.654E+07	1.278E+07	3.260E+07	4.237E+07	1.222E+04	8.776E+07
CE143	1.862E+00	4.734E+00	6.153E+00	6.415E+00	1.917E+01	1.028E+07	2.614E+07	3.394E+07	0.000E+00	7.037E+07
CE144	3.667E+06	9.365E+06	1.214E+07	1.655E+07	4.172E+07	6.539E+06	1.670E+07	2.164E+07	7.307E+06	5.218E+07
CS134	1.452E+05	3.968E+05	3.750E+05	1.548E+06	2.465E+06	3.984E+05	1.099E+06	1.037E+06	1.137E+06	3.671E+06
CS136	5.785E+04	1.520E+05	1.781E+05	2.731E+05	6.610E+05	4.845E+05	1.288E+06	1.460E+06	5.414E-03	3.232E+06

Table 4.17 Fission Products Radioactivity (Curies) of Recycled Oxide Fuel Core (continued)

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
I131	4.689E+05	1.192E+06	1.553E+06	1.609E+06	4.824E+06	9.065E+06	2.304E+07	3.000E+07	4.519E-07	6.211E+07
I132	1.397E+04	3.547E+04	4.611E+04	4.781E+04	1.434E+05	1.225E+07	3.112E+07	4.050E+07	0.000E+00	8.387E+07
KR 85	1.704E+04	4.353E+04	5.617E+04	1.131E+05	2.298E+05	3.373E+04	8.621E+04	1.110E+05	1.066E+05	3.376E+05
KR 85M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.339E+06	3.392E+06	4.413E+06	0.000E+00	9.144E+06
KR 87	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.236E+06	5.654E+06	7.333E+06	0.000E+00	1.522E+07
KR 88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.080E+06	7.784E+06	1.010E+07	0.000E+00	2.096E+07
LA140	1.884E+06	4.790E+06	6.233E+06	6.458E+06	1.937E+07	1.262E+07	3.209E+07	4.163E+07	8.300E-02	8.634E+07
LA141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.263E+07	3.210E+07	4.183E+07	0.000E+00	8.655E+07
LA142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.117E+07	2.837E+07	3.695E+07	0.000E+00	7.649E+07
MO 99	4.810E+03	1.224E+04	1.587E+04	1.672E+04	4.963E+04	1.396E+07	3.553E+07	4.596E+07	0.000E+00	9.544E+07
NB 95	6.597E+06	1.684E+07	2.188E+07	2.308E+07	6.840E+07	1.065E+07	2.720E+07	3.533E+07	1.037E+06	7.421E+07
ND147	5.154E+05	1.311E+06	1.693E+06	1.809E+06	5.328E+06	5.115E+06	1.303E+07	1.675E+07	1.358E-03	3.490E+07
PR143	1.642E+06	4.173E+06	5.427E+06	5.654E+06	1.690E+07	1.027E+07	2.610E+07	3.390E+07	2.054E-01	7.027E+07
RB 86	6.889E+03	1.883E+04	1.791E+04	4.848E+04	9.211E+04	4.408E+04	1.221E+05	1.145E+05	1.890E-01	2.808E+05
RH105	6.906E+00	1.761E+01	2.280E+01	2.429E+01	7.160E+01	1.227E+07	3.130E+07	4.039E+07	0.000E+00	8.396E+07
RU105	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.232E+07	3.147E+07	4.054E+07	0.000E+00	8.433E+07
RU106	4.048E+06	1.038E+07	1.348E+07	1.963E+07	4.754E+07	7.296E+06	1.870E+07	2.430E+07	1.044E+07	6.074E+07
SB127	3.884E+03	9.841E+03	1.278E+04	1.329E+04	3.980E+04	1.276E+06	3.233E+06	4.195E+06	8.081E-23	8.703E+06
SB129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.204E+06	8.134E+06	1.058E+07	0.000E+00	2.192E+07
SR 89	1.843E+06	4.682E+06	6.066E+06	6.312E+06	1.890E+07	4.175E+06	1.061E+07	1.374E+07	6.334E+04	2.859E+07
SR 91	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.703E+06	1.444E+07	1.875E+07	0.000E+00	3.889E+07
SR 92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.809E+06	1.725E+07	2.243E+07	0.000E+00	4.649E+07
TC 99M	4.634E+03	1.179E+04	1.529E+04	1.611E+04	4.782E+04	1.222E+07	3.110E+07	4.023E+07	0.000E+00	8.356E+07

Table 4.17 Fission Products Radioactivity (Curies) of Recycled Oxide Fuel Core (continued)

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
TE127	9.489E+04	2.415E+05	3.135E+05	3.430E+05	9.929E+05	1.262E+06	3.200E+06	4.151E+06	3.919E+04	8.651E+06
TE127M	9.309E+04	2.370E+05	3.076E+05	3.372E+05	9.749E+05	1.657E+05	4.218E+05	5.475E+05	4.001E+04	1.175E+06
TE129	1.118E+05	2.851E+05	3.708E+05	3.837E+05	1.151E+06	3.187E+06	8.104E+06	1.050E+07	3.805E+02	2.179E+07
TE129M	1.717E+05	4.380E+05	5.697E+05	5.895E+05	1.769E+06	4.763E+05	1.214E+06	1.578E+06	5.842E+02	3.269E+06
TE131M	5.411E-02	1.378E-01	1.802E-01	1.854E-01	5.575E-01	1.355E+06	3.447E+06	4.507E+06	0.000E+00	9.309E+06
TE132	1.356E+04	3.443E+04	4.475E+04	4.641E+04	1.391E+05	1.199E+07	3.047E+07	3.966E+07	0.000E+00	8.212E+07
Y 91	2.686E+06	6.830E+06	8.848E+06	9.257E+06	2.762E+07	5.723E+06	1.456E+07	1.885E+07	1.744E+05	3.931E+07
Y 92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.885E+06	1.744E+07	2.268E+07	0.000E+00	4.701E+07
Y 93	2.039E-15	5.171E-15	6.730E-15	6.964E-15	2.090E-14	8.707E+06	2.208E+07	2.873E+07	0.000E+00	5.951E+07
ZR 97	1.188E-06	3.019E-06	3.925E-06	4.091E-06	1.222E-05	1.194E+07	3.034E+07	3.940E+07	0.000E+00	8.168E+07
Others	1.522E+07	3.897E+07	5.032E+07	6.649E+07	1.710E+08	8.195E+08	2.081E+09	2.688E+09	2.428E+07	5.614E+09

Table 4.18 Activation Product Radioactivity (Curies) of Recycled Oxide Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
Total	4.976E+06	1.168E+07	1.365E+07	2.175E+07	5.206E+07	3.345E+07	7.971E+07	9.177E+07	9.364E+06	2.143E+08
RU103	1.784E+02	4.783E+02	2.906E+02	2.228E+03	3.175E+03	9.952E+02	2.754E+03	1.641E+03	6.009E+00	5.396E+03
TC101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.280E+05	1.499E+06	1.725E+06	0.000E+00	3.852E+06
MO101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.280E+05	1.499E+06	1.725E+06	0.000E+00	3.852E+06
ZR 95	1.378E+02	3.254E+02	3.751E+02	4.920E+02	1.330E+03	3.011E+02	7.194E+02	8.203E+02	1.302E+01	1.854E+03
SR 90	1.579E-05	3.964E-05	3.251E-05	1.833E-04	2.712E-04	4.839E-05	1.240E-04	9.937E-05	1.793E-04	4.510E-04
Y 90	8.906E-05	2.242E-04	1.864E-04	6.765E-04	1.176E-03	3.875E-01	9.987E-01	8.180E-01	1.793E-04	2.204E+00
MO 99	7.174E+02	1.695E+03	1.960E+03	2.491E+03	6.864E+03	2.154E+06	5.146E+06	5.899E+06	0.000E+00	1.320E+07
NB 95	3.202E+02	7.572E+02	8.683E+02	1.163E+03	3.109E+03	7.163E+02	1.715E+03	1.937E+03	2.899E+01	4.398E+03
RH105	1.107E-08	3.416E-08	1.067E-08	2.476E-07	3.035E-07	6.798E-02	2.224E-01	6.673E-02	0.000E+00	3.571E-01
RU105	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.833E-02	2.237E-01	6.701E-02	0.000E+00	3.591E-01
RU106	6.611E-08	2.175E-07	4.887E-08	2.208E-06	2.541E-06	5.087E-07	1.796E-06	3.837E-07	1.175E-06	3.864E-06
SR 89	2.096E-02	5.274E-02	4.408E-02	1.515E-01	2.692E-01	7.148E-02	1.838E-01	1.512E-01	1.520E-03	4.080E-01
SR 91	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.283E-03	3.305E-03	2.714E-03	0.000E+00	7.302E-03
Y 91	3.531E-03	8.884E-03	7.420E-03	2.564E-02	4.548E-02	1.141E-02	2.934E-02	2.411E-02	4.830E-04	6.535E-02
Y 92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.745E-01	4.494E-01	3.694E-01	0.000E+00	9.933E-01
Y 93	1.687E-30	4.522E-30	2.703E-30	1.228E-29	2.119E-29	1.119E-08	3.105E-08	1.812E-08	0.000E+00	6.036E-08
ZR 97	6.549E-13	1.546E-12	1.792E-12	2.254E-12	6.248E-12	6.808E+00	1.625E+01	1.870E+01	0.000E+00	4.176E+01
Others	4.974E+06	1.168E+07	1.365E+07	2.174E+07	5.204E+07	3.004E+07	7.156E+07	8.242E+07	9.364E+06	1.934E+08

Table 4.19 Actinide Radioactivity (Curies) of Startup Metal Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
U234	5.056E-03	1.163E-02	1.721E-02	4.329E-02	7.718E-02	1.127E-02	2.552E-02	3.616E-02	6.912E-02	1.421E-01
U235	7.419E-03	1.616E-02	2.729E-02	1.027E-02	6.113E-02	5.461E-03	1.216E-02	2.265E-02	1.032E-02	5.060E-02
U236	1.488E-02	2.961E-02	3.393E-02	6.792E-02	1.463E-01	2.704E-02	5.450E-02	6.456E-02	6.915E-02	2.152E-01
U237	2.374E+04	5.070E+04	5.852E+04	7.601E+04	2.090E+05	8.098E+05	1.743E+06	1.996E+06	4.185E+01	4.549E+06
U238	7.222E-01	1.547E+00	2.445E+00	1.473E+00	6.187E+00	6.939E-01	1.490E+00	2.385E+00	1.473E+00	6.042E+00
U239	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.799E+08	3.583E+08	3.694E+08	0.000E+00	9.076E+08
Np237	1.779E-01	3.852E-01	4.737E-01	9.635E-01	2.000E+00	3.313E-01	7.234E-01	9.079E-01	9.657E-01	2.928E+00
Np238	7.253E+00	1.435E+01	1.190E+01	3.628E+01	6.978E+01	2.654E+05	5.335E+05	4.413E+05	1.712E+00	1.240E+06
Np239	1.725E+04	3.405E+04	3.522E+04	4.725E+04	1.338E+05	1.797E+08	3.579E+08	3.692E+08	1.996E+01	9.069E+08
Pu238	1.718E+03	3.917E+03	5.600E+03	9.481E+03	2.072E+04	3.065E+03	6.703E+03	8.224E+03	1.019E+04	2.818E+04
Pu239	2.798E+04	6.889E+04	1.262E+05	5.900E+04	2.821E+05	2.485E+04	6.032E+04	1.138E+05	5.900E+04	2.580E+05
Pu240	1.191E+04	2.828E+04	4.457E+04	4.448E+04	1.292E+05	1.618E+04	3.769E+04	5.656E+04	4.448E+04	1.549E+05
Pu241	3.916E+05	9.062E+05	1.308E+06	1.783E+06	4.389E+06	6.283E+05	1.416E+06	1.848E+06	1.706E+06	5.597E+06
Pu242	1.082E+00	2.450E+00	3.236E+00	6.305E+00	1.307E+01	2.130E+00	4.653E+00	5.205E+00	6.305E+00	1.829E+01
Pu243	1.163E-09	1.835E-09	4.875E-10	3.380E-08	3.729E-08	8.184E+04	1.657E+05	1.252E+05	3.380E-08	3.727E+05
Am241	4.752E+02	1.118E+03	1.737E+03	4.108E+03	7.439E+03	1.009E+03	2.351E+03	3.569E+03	6.668E+03	1.360E+04
Am242m	2.989E+01	6.652E+01	7.640E+01	3.439E+02	5.167E+02	9.017E+01	2.002E+02	2.265E+02	3.425E+02	8.594E+02
Am242	2.974E+01	6.620E+01	7.604E+01	3.422E+02	5.142E+02	1.312E+05	2.836E+05	2.766E+05	3.407E+02	6.917E+05
Am243	2.286E+00	4.839E+00	4.882E+00	1.997E+01	3.198E+01	6.424E+00	1.338E+01	1.214E+01	1.996E+01	5.190E+01
Am244	1.682E-18	3.264E-18	2.172E-18	1.357E-17	2.068E-17	1.464E+04	2.831E+04	1.663E+04	0.000E+00	5.959E+04
Cm242	2.087E+04	4.556E+04	4.793E+04	2.008E+05	3.151E+05	6.655E+04	1.447E+05	1.444E+05	4.856E+04	4.042E+05
Cm243	7.882E+00	1.565E+01	1.181E+01	1.003E+02	1.356E+02	3.056E+01	6.107E+01	4.428E+01	9.808E+01	2.340E+02
Cm244	9.981E+01	1.964E+02	1.428E+02	1.149E+03	1.588E+03	3.744E+02	7.318E+02	4.830E+02	1.109E+03	2.698E+03
Cm245	1.083E-02	1.993E-02	1.054E-02	1.634E-01	2.047E-01	5.450E-02	1.009E-01	4.930E-02	1.633E-01	3.680E-01
Total	4.958E+05	1.139E+06	1.628E+06	2.226E+06	5.489E+06	3.617E+08	7.210E+08	7.438E+08	1.877E+06	1.828E+09
TRU	4.721E+05	1.088E+06	1.570E+06	2.150E+06	5.280E+06	1.810E+08	3.609E+08	3.724E+08	1.877E+06	9.162E+08

Table 4.20 Fission Product Radioactivity (Curies) of Startup Metal Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
Total	6.539E+07	1.496E+08	1.829E+08	2.266E+08	6.245E+08	1.478E+09	3.369E+09	4.121E+09	4.724E+07	9.016E+09
XE135	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.919E+07	4.385E+07	5.387E+07	0.000E+00	1.169E+08
I134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.852E+07	4.229E+07	5.200E+07	0.000E+00	1.128E+08
RU103	7.052E+06	1.615E+07	1.970E+07	2.209E+07	6.499E+07	1.818E+07	4.161E+07	5.055E+07	5.958E+04	1.104E+08
XE133	2.772E+05	6.330E+05	7.776E+05	8.500E+05	2.538E+06	1.792E+07	4.091E+07	5.015E+07	4.894E-14	1.090E+08
I133	4.544E-04	1.038E-03	1.279E-03	1.385E-03	4.157E-03	1.755E+07	4.009E+07	4.936E+07	0.000E+00	1.070E+08
TC103	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.738E+07	3.974E+07	4.897E+07	0.000E+00	1.061E+08
TC102	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.718E+07	3.924E+07	4.831E+07	0.000E+00	1.047E+08
MO102	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.714E+07	3.916E+07	4.821E+07	0.000E+00	1.045E+08
I135	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.691E+07	3.863E+07	4.754E+07	0.000E+00	1.031E+08
MO103	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.697E+07	3.880E+07	4.779E+07	0.000E+00	1.036E+08
TC104	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.661E+07	3.797E+07	4.675E+07	0.000E+00	1.013E+08
TC101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.728E+07	3.944E+07	4.829E+07	0.000E+00	1.050E+08
MO101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.727E+07	3.942E+07	4.826E+07	0.000E+00	1.050E+08
CS138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.618E+07	3.696E+07	4.547E+07	0.000E+00	9.861E+07
ZR 95	6.082E+06	1.392E+07	1.706E+07	1.874E+07	5.580E+07	1.267E+07	2.900E+07	3.555E+07	4.959E+05	7.772E+07
SR 90	1.261E+05	2.880E+05	3.517E+05	7.530E+05	1.519E+06	2.505E+05	5.722E+05	6.990E+05	7.366E+05	2.258E+06
Y 90	1.262E+05	2.883E+05	3.519E+05	7.536E+05	1.520E+06	2.764E+05	6.293E+05	7.457E+05	7.370E+05	2.388E+06
CS137	3.441E+05	7.892E+05	9.661E+05	2.066E+06	4.166E+06	6.839E+05	1.569E+06	1.921E+06	2.023E+06	6.196E+06
BA139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.516E+07	3.460E+07	4.254E+07	0.000E+00	9.230E+07
BA140	1.831E+06	4.183E+06	5.146E+06	5.585E+06	1.675E+07	1.397E+07	3.190E+07	3.924E+07	7.176E-02	8.511E+07
CE141	5.170E+06	1.184E+07	1.453E+07	1.579E+07	4.733E+07	1.463E+07	3.349E+07	4.111E+07	1.241E+04	8.925E+07
CE143	2.111E+00	4.822E+00	5.924E+00	6.469E+00	1.933E+01	1.166E+07	2.662E+07	3.267E+07	0.000E+00	7.096E+07
CE144	4.109E+06	9.406E+06	1.151E+07	1.646E+07	4.148E+07	7.326E+06	1.677E+07	2.053E+07	7.264E+06	5.189E+07
CS134	1.896E+05	4.140E+05	3.456E+05	1.609E+06	2.558E+06	5.219E+05	1.150E+06	9.580E+05	1.182E+06	3.812E+06
CS136	7.473E+04	1.686E+05	1.838E+05	2.961E+05	7.233E+05	6.286E+05	1.419E+06	1.490E+06	5.870E-03	3.537E+06

Table 4.20 Fission Product Radioactivity (Curies) of Startup Metal Fuel Core (continued)

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
I131	5.350E+05	1.223E+06	1.506E+06	1.633E+06	4.896E+06	1.033E+07	2.361E+07	2.906E+07	4.586E-07	6.300E+07
I132	1.575E+04	3.604E+04	4.433E+04	4.803E+04	1.442E+05	1.387E+07	3.168E+07	3.898E+07	0.000E+00	8.453E+07
KR 85	2.089E+04	4.770E+04	5.801E+04	1.227E+05	2.493E+05	4.136E+04	9.449E+04	1.147E+05	1.157E+05	3.662E+05
KR 85M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.626E+06	3.706E+06	4.559E+06	0.000E+00	9.890E+06
KR 87	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.650E+06	6.031E+06	7.400E+06	0.000E+00	1.608E+07
KR 88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.681E+06	8.374E+06	1.028E+07	0.000E+00	2.233E+07
LA140	2.107E+06	4.812E+06	5.923E+06	6.426E+06	1.927E+07	1.413E+07	3.226E+07	3.955E+07	8.260E-02	8.594E+07
LA141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.444E+07	3.299E+07	4.064E+07	0.000E+00	8.807E+07
LA142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.273E+07	2.907E+07	3.579E+07	0.000E+00	7.759E+07
MO 99	5.432E+03	1.240E+04	1.519E+04	1.679E+04	4.982E+04	1.578E+07	3.601E+07	4.399E+07	0.000E+00	9.579E+07
NB 95	7.722E+06	1.768E+07	2.168E+07	2.397E+07	7.105E+07	1.246E+07	2.854E+07	3.500E+07	1.077E+06	7.708E+07
ND147	5.756E+05	1.312E+06	1.601E+06	1.798E+06	5.286E+06	5.728E+06	1.305E+07	1.584E+07	1.350E-03	3.462E+07
PR143	1.861E+06	4.250E+06	5.224E+06	5.702E+06	1.704E+07	1.164E+07	2.657E+07	3.263E+07	2.071E-01	7.085E+07
RB 86	9.711E+03	2.121E+04	1.786E+04	5.452E+04	1.033E+05	6.258E+04	1.381E+05	1.142E+05	2.126E-01	3.149E+05
RH105	7.546E+00	1.724E+01	2.110E+01	2.359E+01	6.948E+01	1.343E+07	3.068E+07	3.736E+07	0.000E+00	8.147E+07
RU105	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.351E+07	3.084E+07	3.749E+07	0.000E+00	8.184E+07
RU106	4.247E+06	9.764E+06	1.198E+07	1.828E+07	4.428E+07	7.658E+06	1.760E+07	2.160E+07	9.725E+06	5.658E+07
SB127	4.509E+03	1.028E+04	1.261E+04	1.376E+04	4.116E+04	1.482E+06	3.377E+06	4.142E+06	8.361E-23	9.001E+06
SB129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.656E+06	8.346E+06	1.026E+07	0.000E+00	2.227E+07
SR 89	2.234E+06	5.095E+06	6.234E+06	6.802E+06	2.036E+07	5.059E+06	1.155E+07	1.413E+07	6.825E+04	3.080E+07
SR 91	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.837E+06	1.557E+07	1.912E+07	0.000E+00	4.153E+07
SR 92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.102E+06	1.847E+07	2.271E+07	0.000E+00	4.929E+07
TC 99M	5.234E+03	1.195E+04	1.463E+04	1.618E+04	4.799E+04	1.382E+07	3.153E+07	3.851E+07	0.000E+00	8.386E+07

Table 4.20 Fission Product Radioactivity (Curies) of Startup Metal Fuel Core – (continue)

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
TE127	1.102E+05	2.518E+05	3.089E+05	3.546E+05	1.025E+06	1.466E+06	3.342E+06	4.099E+06	4.051E+04	8.947E+06
TE127M	1.081E+05	2.471E+05	3.031E+05	3.486E+05	1.007E+06	1.924E+05	4.400E+05	5.398E+05	4.136E+04	1.214E+06
TE129	1.296E+05	2.966E+05	3.643E+05	3.949E+05	1.185E+06	3.658E+06	8.346E+06	1.022E+07	3.917E+02	2.222E+07
TE129M	1.991E+05	4.558E+05	5.597E+05	6.066E+05	1.821E+06	5.519E+05	1.263E+06	1.551E+06	6.015E+02	3.367E+06
TE131M	6.394E-02	1.464E-01	1.807E-01	1.944E-01	5.855E-01	1.599E+06	3.660E+06	4.520E+06	0.000E+00	9.779E+06
TE132	1.527E+04	3.498E+04	4.298E+04	4.658E+04	1.398E+05	1.356E+07	3.097E+07	3.810E+07	0.000E+00	8.262E+07
Y 91	3.226E+06	7.363E+06	9.002E+06	9.877E+06	2.947E+07	6.871E+06	1.569E+07	1.918E+07	1.861E+05	4.193E+07
Y 92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.202E+06	1.870E+07	2.299E+07	0.000E+00	4.989E+07
Y 93	2.407E-15	5.490E-15	6.752E-15	7.319E-15	2.197E-14	1.027E+07	2.344E+07	2.883E+07	0.000E+00	6.254E+07
ZR 97	1.369E-06	3.126E-06	3.840E-06	4.194E-06	1.253E-05	1.376E+07	3.141E+07	3.855E+07	0.000E+00	8.372E+07
Others	1.687E+07	3.863E+07	4.710E+07	6.510E+07	1.677E+08	9.027E+08	2.056E+09	2.510E+09	2.348E+07	5.493E+09

Table 4.21 Activation Products Radioactivity (Curies) of Startup Metal Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
Total	6.508E+06	1.360E+07	1.486E+07	2.467E+07	5.964E+07	4.161E+07	8.773E+07	9.413E+07	9.645E+06	2.331E+08
RU103	2.730E+02	5.134E+02	2.551E+02	2.487E+03	3.528E+03	1.550E+03	2.991E+03	1.449E+03	6.707E+00	5.996E+03
TC101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.297E+05	1.540E+06	1.653E+06	0.000E+00	3.923E+06
MO101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.297E+05	1.540E+06	1.653E+06	0.000E+00	3.923E+06
ZR 95	3.512E+05	7.346E+05	7.956E+05	1.088E+06	2.970E+06	7.655E+05	1.614E+06	1.731E+06	2.880E+04	4.139E+06
SR 90	2.919E-02	5.749E-02	4.228E-02	2.428E-01	3.718E-01	8.395E-02	1.675E-01	1.211E-01	2.376E-01	6.101E-01
Y 90	5.496E+00	1.150E+01	1.240E+01	1.701E+01	4.641E+01	2.089E+04	4.409E+04	4.715E+04	2.376E-01	1.121E+05
MO 99	8.301E+02	1.737E+03	1.874E+03	2.554E+03	6.995E+03	2.508E+06	5.292E+06	5.651E+06	0.000E+00	1.345E+07
NB 95	4.427E+05	9.258E+05	1.004E+06	1.381E+06	3.754E+06	7.438E+05	1.567E+06	1.685E+06	6.252E+04	4.059E+06
RH105	2.278E-08	3.869E-08	8.612E-09	3.176E-07	3.877E-07	1.447E-01	2.572E-01	5.438E-02	0.000E+00	4.563E-01
RU105	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.455E-01	2.587E-01	5.461E-02	0.000E+00	4.589E-01
RU106	1.571E-07	2.523E-07	3.774E-08	3.048E-06	3.496E-06	1.261E-06	2.138E-06	2.998E-07	1.622E-06	5.320E-06
SR 89	2.393E+02	5.003E+02	5.399E+02	7.411E+02	2.021E+03	5.694E+02	1.200E+03	1.281E+03	7.437E+00	3.058E+03
SR 91	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.098E+02	2.316E+02	2.477E+02	0.000E+00	5.891E+02
Y 91	6.440E+02	1.346E+03	1.452E+03	2.001E+03	5.443E+03	1.450E+03	3.056E+03	3.259E+03	3.771E+01	7.803E+03
Y 92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.245E+03	2.626E+03	2.800E+03	0.000E+00	6.671E+03
Y 93	8.460E-23	1.771E-22	1.915E-22	2.590E-22	7.122E-22	3.774E-01	7.965E-01	8.528E-01	0.000E+00	2.027E+00
ZR 97	2.448E-08	5.125E-08	5.540E-08	7.493E-08	2.061E-07	2.564E+05	5.412E+05	5.795E+05	0.000E+00	1.377E+06
Others	5.712E+06	1.193E+07	1.306E+07	2.219E+07	5.289E+07	3.586E+07	7.558E+07	8.112E+07	9.553E+06	2.021E+08

Table 4.22 Actinide Radioactivity (Curies) of Startup Oxide Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
U234	4.539E-03	1.061E-02	1.624E-02	4.036E-02	7.175E-02	1.015E-02	2.333E-02	3.408E-02	6.670E-02	1.343E-01
U235	5.257E-03	1.126E-02	1.891E-02	6.642E-03	4.206E-02	3.739E-03	8.171E-03	1.534E-02	6.688E-03	3.394E-02
U236	1.221E-02	2.436E-02	2.776E-02	5.535E-02	1.197E-01	2.209E-02	4.455E-02	5.273E-02	5.673E-02	1.761E-01
U237	1.794E+04	3.848E+04	4.427E+04	6.093E+04	1.616E+05	6.265E+05	1.354E+06	1.535E+06	5.505E+01	3.516E+06
U238	5.207E-01	1.099E+00	1.716E+00	1.032E+00	4.367E+00	4.978E-01	1.053E+00	1.668E+00	1.032E+00	4.251E+00
U239	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.487E+08	2.979E+08	3.006E+08	0.000E+00	7.472E+08
Np237	1.278E-01	2.782E-01	3.467E-01	7.000E-01	1.453E+00	2.378E-01	5.215E-01	6.643E-01	7.026E-01	2.126E+00
Np238	6.447E+00	1.303E+01	1.084E+01	3.478E+01	6.510E+01	2.404E+05	4.934E+05	4.048E+05	2.292E+00	1.139E+06
Np239	1.401E+04	2.780E+04	2.830E+04	4.005E+04	1.102E+05	1.486E+08	2.976E+08	3.004E+08	3.248E+01	7.466E+08
Pu238	1.669E+03	3.870E+03	5.653E+03	9.468E+03	2.066E+04	2.956E+03	6.587E+03	8.234E+03	1.052E+04	2.830E+04
Pu239	2.769E+04	6.840E+04	1.270E+05	5.408E+04	2.771E+05	2.338E+04	5.707E+04	1.109E+05	5.408E+04	2.455E+05
Pu240	1.329E+04	3.163E+04	4.904E+04	5.105E+04	1.450E+05	1.843E+04	4.317E+04	6.399E+04	5.105E+04	1.766E+05
Pu241	4.750E+05	1.097E+06	1.513E+06	2.346E+06	5.432E+06	8.089E+05	1.831E+06	2.282E+06	2.244E+06	7.166E+06
Pu242	1.375E+00	3.102E+00	3.817E+00	9.156E+00	1.745E+01	3.005E+00	6.586E+00	6.735E+00	9.156E+00	2.548E+01
Pu243	3.081E-09	5.171E-09	1.361E-09	1.087E-07	1.183E-07	1.467E+05	3.027E+05	2.039E+05	1.087E-07	6.533E+05
Am241	5.538E+02	1.300E+03	1.948E+03	4.907E+03	8.709E+03	1.197E+03	2.783E+03	4.083E+03	8.274E+03	1.634E+04
Am242m	3.839E+01	8.630E+01	9.657E+01	4.603E+02	6.815E+02	1.195E+02	2.682E+02	2.940E+02	4.583E+02	1.140E+03
Am242	3.820E+01	8.588E+01	9.607E+01	4.579E+02	6.780E+02	1.912E+05	4.193E+05	3.868E+05	4.560E+02	9.978E+05
Am243	3.293E+00	7.050E+00	6.688E+00	3.248E+01	4.951E+01	1.019E+01	2.150E+01	1.777E+01	3.248E+01	8.194E+01
Am244	3.002E-18	5.967E-18	3.704E-18	2.909E-17	4.176E-17	2.988E+04	5.934E+04	3.108E+04	0.000E+00	1.203E+05
Cm242	2.808E+04	6.204E+04	6.276E+04	2.923E+05	4.452E+05	9.496E+04	2.091E+05	1.981E+05	7.065E+04	5.728E+05
Cm243	1.393E+01	2.823E+01	2.029E+01	1.930E+02	2.555E+02	5.792E+01	1.181E+02	7.994E+01	1.887E+02	4.447E+02
Cm244	1.667E+02	3.361E+02	2.326E+02	2.204E+03	2.939E+03	6.987E+02	1.399E+03	8.430E+02	2.128E+03	5.069E+03
Cm245	2.049E-02	3.914E-02	1.999E-02	3.596E-01	4.392E-01	1.162E-01	2.227E-01	1.003E-01	3.596E-01	7.988E-01
Total	5.785E+05	1.332E+06	1.833E+06	2.862E+06	6.605E+06	2.996E+08	6.006E+08	6.063E+08	2.442E+06	1.509E+09
TRU	5.606E+05	1.293E+06	1.788E+06	2.801E+06	6.443E+06	1.502E+08	3.014E+08	3.042E+08	2.442E+06	7.582E+08

Table 4.23 Fission Product Radioactivity (Curies) of Startup Oxide Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
Total	6.402E+07	1.500E+08	1.871E+08	2.285E+08	6.296E+08	1.432E+09	3.343E+09	4.177E+09	4.788E+07	9.000E+09
XE135	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.870E+07	4.375E+07	5.497E+07	0.000E+00	1.174E+08
I134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.803E+07	4.211E+07	5.292E+07	0.000E+00	1.131E+08
RU103	6.923E+06	1.623E+07	2.022E+07	2.234E+07	6.572E+07	1.785E+07	4.185E+07	5.188E+07	6.026E+04	1.116E+08
XE133	2.697E+05	6.308E+05	7.924E+05	8.513E+05	2.544E+06	1.743E+07	4.074E+07	5.107E+07	4.901E-14	1.092E+08
I133	4.421E-04	1.034E-03	1.302E-03	1.386E-03	4.165E-03	1.707E+07	3.990E+07	5.024E+07	0.000E+00	1.072E+08
TC103	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.696E+07	3.967E+07	5.000E+07	0.000E+00	1.066E+08
TC102	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.671E+07	3.907E+07	4.919E+07	0.000E+00	1.050E+08
MO102	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.667E+07	3.898E+07	4.908E+07	0.000E+00	1.047E+08
I135	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.646E+07	3.848E+07	4.843E+07	0.000E+00	1.034E+08
MO103	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.655E+07	3.872E+07	4.879E+07	0.000E+00	1.041E+08
TC104	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.624E+07	3.799E+07	4.782E+07	0.000E+00	1.021E+08
TC101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.680E+07	3.927E+07	4.917E+07	0.000E+00	1.052E+08
MO101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.679E+07	3.925E+07	4.914E+07	0.000E+00	1.052E+08
CS138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.575E+07	3.683E+07	4.633E+07	0.000E+00	9.892E+07
ZR 95	5.937E+06	1.391E+07	1.740E+07	1.879E+07	5.604E+07	1.236E+07	2.896E+07	3.623E+07	4.973E+05	7.805E+07
SR 90	1.223E+05	2.862E+05	3.561E+05	7.514E+05	1.516E+06	2.429E+05	5.682E+05	7.078E+05	7.348E+05	2.254E+06
Y 90	1.224E+05	2.864E+05	3.563E+05	7.519E+05	1.517E+06	2.681E+05	6.263E+05	7.561E+05	7.352E+05	2.386E+06
CS137	3.391E+05	7.960E+05	9.929E+05	2.094E+06	4.222E+06	6.740E+05	1.582E+06	1.974E+06	2.050E+06	6.280E+06
BA139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.474E+07	3.444E+07	4.329E+07	0.000E+00	9.247E+07
BA140	1.782E+06	4.167E+06	5.242E+06	5.592E+06	1.678E+07	1.359E+07	3.177E+07	3.994E+07	7.189E-02	8.530E+07
CE141	5.064E+06	1.187E+07	1.487E+07	1.589E+07	4.769E+07	1.432E+07	3.355E+07	4.206E+07	1.250E+04	8.995E+07
CE143	2.052E+00	4.797E+00	6.026E+00	6.471E+00	1.935E+01	1.133E+07	2.647E+07	3.322E+07	0.000E+00	7.102E+07
CE144	4.023E+06	9.427E+06	1.176E+07	1.657E+07	4.178E+07	7.175E+06	1.681E+07	2.097E+07	7.320E+06	5.227E+07
CS134	1.808E+05	4.138E+05	3.556E+05	1.663E+06	2.613E+06	5.092E+05	1.176E+06	1.001E+06	1.221E+06	3.908E+06
CS136	7.315E+04	1.705E+05	1.906E+05	3.063E+05	7.406E+05	6.201E+05	1.449E+06	1.552E+06	6.074E-03	3.621E+06

Table 4.23 Fission Product Radioactivity (Curies) of Startup Oxide Fuel Core (continued)

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
I131	5.208E+05	1.219E+06	1.535E+06	1.634E+06	4.909E+06	1.005E+07	2.350E+07	2.959E+07	4.590E-07	6.314E+07
I132	1.535E+04	3.585E+04	4.514E+04	4.806E+04	1.444E+05	1.349E+07	3.154E+07	3.968E+07	0.000E+00	8.472E+07
KR 85	2.031E+04	4.751E+04	5.891E+04	1.228E+05	2.495E+05	4.019E+04	9.407E+04	1.165E+05	1.157E+05	3.664E+05
KR 85M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.560E+06	3.641E+06	4.587E+06	0.000E+00	9.788E+06
KR 87	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.533E+06	5.901E+06	7.407E+06	0.000E+00	1.584E+07
KR 88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.514E+06	8.182E+06	1.027E+07	0.000E+00	2.197E+07
LA140	2.051E+06	4.796E+06	6.033E+06	6.436E+06	1.932E+07	1.375E+07	3.213E+07	4.028E+07	8.272E-02	8.616E+07
LA141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.405E+07	3.286E+07	4.142E+07	0.000E+00	8.833E+07
LA142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.237E+07	2.890E+07	3.640E+07	0.000E+00	7.767E+07
MO 99	5.280E+03	1.234E+04	1.546E+04	1.682E+04	4.991E+04	1.534E+07	3.585E+07	4.476E+07	0.000E+00	9.596E+07
NB 95	7.552E+06	1.770E+07	2.213E+07	2.407E+07	7.145E+07	1.219E+07	2.858E+07	3.574E+07	1.080E+06	7.758E+07
ND147	5.577E+05	1.302E+06	1.624E+06	1.799E+06	5.283E+06	5.556E+06	1.296E+07	1.608E+07	1.350E-03	3.460E+07
PR143	1.808E+06	4.228E+06	5.314E+06	5.703E+06	1.705E+07	1.131E+07	2.643E+07	3.318E+07	2.071E-01	7.092E+07
RB 86	9.236E+03	2.115E+04	1.831E+04	5.687E+04	1.056E+05	6.110E+04	1.414E+05	1.193E+05	2.217E-01	3.218E+05
RH105	7.382E+00	1.728E+01	2.160E+01	2.382E+01	7.008E+01	1.315E+07	3.076E+07	3.827E+07	0.000E+00	8.218E+07
RU105	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.323E+07	3.093E+07	3.840E+07	0.000E+00	8.256E+07
RU106	4.222E+06	9.928E+06	1.241E+07	1.869E+07	4.525E+07	7.614E+06	1.790E+07	2.237E+07	9.941E+06	5.782E+07
SB127	4.334E+03	1.010E+04	1.269E+04	1.360E+04	4.073E+04	1.424E+06	3.321E+06	4.167E+06	8.267E-23	8.912E+06
SB129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.541E+06	8.269E+06	1.040E+07	0.000E+00	2.221E+07
SR 89	2.154E+06	5.032E+06	6.285E+06	6.741E+06	2.021E+07	4.875E+06	1.139E+07	1.424E+07	6.763E+04	3.057E+07
SR 91	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.553E+06	1.528E+07	1.920E+07	0.000E+00	4.103E+07
SR 92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.789E+06	1.818E+07	2.287E+07	0.000E+00	4.884E+07
TC 99M	5.086E+03	1.189E+04	1.489E+04	1.621E+04	4.808E+04	1.343E+07	3.139E+07	3.919E+07	0.000E+00	8.401E+07

Table 4.23 Fission Product Radioactivity (Curies) of Startup Oxide Fuel Core (continued)

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
TE127	1.068E+05	2.499E+05	3.127E+05	3.533E+05	1.023E+06	1.411E+06	3.291E+06	4.126E+06	4.038E+04	8.868E+06
TE127M	1.049E+05	2.453E+05	3.068E+05	3.475E+05	1.004E+06	1.867E+05	4.367E+05	5.464E+05	4.123E+04	1.211E+06
TE129	1.266E+05	2.965E+05	3.718E+05	3.961E+05	1.191E+06	3.546E+06	8.284E+06	1.037E+07	3.930E+02	2.220E+07
TE129M	1.944E+05	4.557E+05	5.712E+05	6.084E+05	1.830E+06	5.384E+05	1.261E+06	1.582E+06	6.035E+02	3.382E+06
TE131M	6.253E-02	1.466E-01	1.852E-01	1.950E-01	5.893E-01	1.561E+06	3.657E+06	4.625E+06	0.000E+00	9.842E+06
TE132	1.488E+04	3.472E+04	4.379E+04	4.663E+04	1.400E+05	1.319E+07	3.083E+07	3.878E+07	0.000E+00	8.280E+07
Y 91	3.118E+06	7.285E+06	9.094E+06	9.814E+06	2.931E+07	6.638E+06	1.551E+07	1.937E+07	1.848E+05	4.171E+07
Y 92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.885E+06	1.840E+07	2.316E+07	0.000E+00	4.944E+07
Y 93	2.322E-15	5.424E-15	6.827E-15	7.258E-15	2.183E-14	9.905E+06	2.313E+07	2.912E+07	0.000E+00	6.215E+07
ZR 97	1.329E-06	3.106E-06	3.903E-06	4.187E-06	1.252E-05	1.335E+07	3.119E+07	3.915E+07	0.000E+00	8.369E+07
Others	1.659E+07	3.891E+07	4.833E+07	6.598E+07	1.698E+08	8.727E+08	2.035E+09	2.537E+09	2.377E+07	5.468E+09

Table 4.24 Activation Product Radioactivity (Curies) of Startup Oxide Fuel Core

	BOEC					EOEC				
	Inner Core	Middle Core	Outer Core	In-vessel storage	Total	Inner Core	Middle Core	Outer Core	In-vessel storage	Total
Total	5.475E+06	1.173E+07	1.302E+07	2.271E+07	5.293E+07	3.831E+07	8.287E+07	8.934E+07	9.747E+06	2.203E+08
RU103	2.433E+02	4.943E+02	2.549E+02	2.589E+03	3.581E+03	1.480E+03	3.085E+03	1.517E+03	6.982E+00	6.088E+03
TC101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.219E+05	1.564E+06	1.684E+06	0.000E+00	3.970E+06
MO101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.219E+05	1.564E+06	1.684E+06	0.000E+00	3.970E+06
ZR 95	1.538E+02	3.297E+02	3.589E+02	5.261E+02	1.368E+03	3.465E+02	7.494E+02	7.983E+02	1.392E+01	1.908E+03
SR 90	1.922E-05	3.981E-05	2.935E-05	1.957E-04	2.840E-04	6.214E-05	1.303E-04	9.210E-05	1.914E-04	4.760E-04
Y 90	1.099E-04	2.291E-04	1.704E-04	7.459E-04	1.255E-03	5.089E-01	1.081E+00	7.759E-01	1.915E-04	2.366E+00
MO 99	8.027E+02	1.723E+03	1.880E+03	2.671E+03	7.078E+03	2.480E+06	5.373E+06	5.757E+06	0.000E+00	1.361E+07
NB 95	3.580E+02	7.673E+02	8.305E+02	1.246E+03	3.202E+03	8.276E+02	1.789E+03	1.884E+03	3.100E+01	4.531E+03
RH105	1.908E-08	3.683E-08	8.683E-09	3.389E-07	4.035E-07	1.372E-01	2.780E-01	5.969E-02	0.000E+00	4.749E-01
RU105	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.381E-01	2.796E-01	5.993E-02	0.000E+00	4.776E-01
RU106	1.260E-07	2.361E-07	3.794E-08	3.220E-06	3.620E-06	1.172E-06	2.325E-06	3.331E-07	1.713E-06	5.543E-06
SR 89	2.582E-02	5.387E-02	4.035E-02	1.678E-01	2.878E-01	9.333E-02	1.980E-01	1.432E-01	1.684E-03	4.362E-01
SR 91	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.683E-03	3.575E-03	2.576E-03	0.000E+00	7.834E-03
Y 91	4.350E-03	9.070E-03	6.785E-03	2.840E-02	4.860E-02	1.490E-02	3.160E-02	2.282E-02	5.351E-04	6.986E-02
Y 92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.288E-01	4.860E-01	3.505E-01	0.000E+00	1.065E+00
Y 93	2.295E-30	4.658E-30	2.345E-30	1.456E-29	2.386E-29	1.668E-08	3.467E-08	1.664E-08	0.000E+00	6.798E-08
ZR 97	7.320E-13	1.572E-12	1.720E-12	2.416E-12	6.441E-12	7.829E+00	1.696E+01	1.825E+01	0.000E+00	4.304E+01
Others	5.474E+06	1.173E+07	1.301E+07	2.270E+07	5.292E+07	3.438E+07	7.436E+07	8.021E+07	9.747E+06	1.987E+08

5. Conclusions

The isotopic inventories of a 2000 MWt ABR core have been estimated for reactor accident consequence analyses. Based on the Super-PRISM design, a preliminary core design of 2000 MWt ABR was developed to achieve a one-year cycle length with three-batch fuel management scheme. By changing the fuel compositions, isotopic inventories of mass and radioactivity were evaluated for four different core configurations: recycled metal fuel core, recycled oxide fuel core, startup metal fuel core, and startup oxide fuel core. Core size and fuel volume fraction of the preliminary core design were selected such that the TRU conversion ratio of a recycled equilibrium core is ~0.3 and a one-year cycle length is achieved with three-batch fuel management scheme. Assembly design parameters were determined to yield the selected fuel volume fraction while satisfying the linear power limit with a significant margin. For all four cases, the TRU enrichment was determined to meet the target cycle length of one-year, allowing the TRU conversion ratio to vary. For recycled cores, the TRU recovered from ABR spent fuel was used as the primary TRU feed, and the TRU recovered from 10-year cooled light water reactor spent fuel (LWR-SF) was used as the makeup TRU feed. For startup cores, weapons-grade plutonium (WG-Pu) driver fuels were assumed without recycling ABR spent fuel, and twelve test fuel assemblies made of LWR-SF TRU were introduced.

Detailed isotopic inventories were estimated by REBUS-3/ORIGEN-2 coupled calculations. It was assumed that a whole batch of discharged fuel assemblies is stored in the in-vessel storage for an entire irradiation cycle. For the recycled cores, the isotopic inventories of metal and oxide fuel cores are similar. The estimated total heavy metal mass at BOEC, including the TRU in the spent fuels stored in the in-vessel storage, is 17.8 MT for the metal fuel core and 18.1 MT for the oxide fuel core. The TRU loading at BOEC is 8.5 MT for the metal core and 8.7 MT for the oxide core. For both metal and oxide cores, the total fission product inventories at BOEC and EOEC are 1.4 MT and 2.0 MT, respectively.

For the startup core, the heavy metal mass of the metal core increases to 23.6 MT from 17.8 MT of the recycled core, since the Zr fraction is decreased from 20% to 10% within the same geometry. However, the heavy metal mass of the oxide core is comparable to the recycled core with a minor variation due to the TRU feed change. For both metal and oxide cores, the TRU masses are reduced to 5.2 MT since weapons-grade plutonium is used and the fission product inventories are practically the same to those of the recycled core because the same power was generated.

The total radioactivity at BOEC is about 8.2×10^{8} curies in recycled cores and about 6.9×10^{8} curies in startup cores, and the total radioactivity at EOEC is about 1.1×10^{10} curies for all four cases. Fission products are the dominant contributor to the total radioactivity. The contribution of fission products is more than 80% at EOEC. Since the same amount of energy is generated, the radioactivity of fission products is practically the same for all four cases; it is about 6.2×10^{8} curies at BOEC and about 9.1×10^{8} curies at EOEC. The heavy metal radioactivity in recycled

cores is about 1.4×10^{8} curies at BOEC and about 1.4×10^{9} curies at EOEC. The leading contributors are Pu-241, Cm-242, Cm-244, and Pu-238 at BOEC and the short-lived nuclides such as U-239, Np-239, Pu-243, and Am242 at EOEC. It is noted that the short-lived isotopes are dominant contributors during reactor operation, but they decay out quickly during the refueling time. After one-year cooling, the fission product radioactivity is reduced by about 80% but the heavy metal radioactivity is reduced by only about 40% for the recycled cores and about 15% for the startup cores.

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